# PSWN Program Symposium Compilation Report
# August 1997 – December 1999

The Public Safety Wireless Network (PSWN) Program has sponsored symposiums in Charlotte, NC; Harrisburg, PA; Sacramento, CA; Boston, MA; Chicago, IL; Mesa, AZ; Denver, CO; Lansing, MI; and Orlando, FL. The program also sponsored a mini-symposium in Washington, DC. The purpose of these events has been to discuss issues related to the interoperability of public safety land mobile radio communications and public safety shared systems. During the course of the symposiums, the PSWN Program has collected common observations and best practices. This report contains information collected and disseminated at the symposiums. As additional symposiums are held, new information will be added to this report to ensure its completeness in the future.

Principal topics discussed during PSWN Program symposiums have included (page numbers are provided for reference):

## CATALYSTS AND DRIVERS FOR SHARED SYSTEM DEVELOPMENT

Recent major public safety events have highlighted the growing demand for multi-agency response teams, which, in turn, has highlighted the need for systems that enable greater communications interoperability. However, the current environment for public safety radio communications is frustrated by insufficient and varied spectrum resources, inadequate funding, and aging technology. Shared systems provide a means for relieving these frustrations. A number of catalysts and drivers for their development were identified:

- **Spectrum:** Public safety agencies require additional spectrum to alleviate congestion, interference, provide interoperability bands, and to support additional services such as mobile data applications. Shared systems allow for the pooling of spectrum resources and, depending on design specifics, can enable more efficient use of spectrum.

- **Funding:** Funding for public safety radio communications is tightening while the cost of technology continues to rise. In many cases, it is becoming prohibitively expensive for individual agencies to procure their own radio communications systems. Many public safety agencies are realizing that consolidation of fiscal resources and capital assets may represent the only way new systems can be afforded.

- **"Reinventing" Government Initiatives:** In a time of diminishing resources, many government agencies are consolidating and leveraging their efforts to achieve common objectives. The development of shared systems for public safety communications is a case in point. Public safety agencies are increasingly compelled to develop shared systems to achieve economies of scale and scope.

- **Availability of Resources:** Public safety agencies may possess or have access to differing resources that can be combined to meet each others needs. One agency may have existing infrastructure and facilities, but lack the financial resources to build upon them. Another agency may have financial resources they can exploit, but no personnel to dedicate to the effort. Many public safety agencies are realizing synergies from combining resources to develop shared systems.

- **Duplication of Infrastructure:** Public safety agencies that can afford their own systems are recognizing that the continued duplication of physical infrastructure and single-agency systems is costly and not emblematic of good public management. For these agencies, developing shared systems is attractive because of the increased cost

- **A Need to Enhance Public Safety Communications:** The implementation of shared systems enables the broad-based adoption of more technologically advanced radio communications equipment and services, which, in turn, greatly enhance public safety operations. While technological advancement can be achieved through single-agency systems, shared systems accelerate the introduction and integration of new technologies and applications throughout the public safety community.

- **Aging Infrastructure:** Existing radio and microwave systems are becoming obsolete and high maintenance costs are making them less economically viable to sustain.

- **Operations in Different Frequency Bands:** Public safety agencies currently employ different frequency bands, ranging from low-band very high frequency (VHF) to high-band ultra high frequency (UHF). These differences typically lead to incompatibilities that hinder interoperability. However, in some cases, it provides a flexible means of partitioning operations or environments for more effective and efficient communications.

- **Changing Regulatory Environment:** The current regulatory environment requires narrowbanding, refarming, and spectrum reallocation to accommodate shared system development and other schemes that promote interoperability.

- **Advancing Technology:** The current technological environment can allow public safety entities to establish more feature-rich and flexible systems. New technology provides greater clarity than previous technology, supports mobile data requirements, and permits multi-agency use and wide-area roaming.

- **Increased Coverage/Range:** A shared system can provide agencies expanded range over existing, individually owned, systems and ensure communications coverage when passing into other jurisdictions. The consolidation of systems may provide expanded range that can prove essential to providing reliable communications for inter- and intra-agency mutual aid operations.

## PARTNERSHIPS FOR SHARED SYSTEM DEVELOPMENT

Developing partnerships and participation arrangements is a key first step in establishing a

the willingness to set aside turf issues to move toward common goals, and the commitment, on behalf of participating agencies, to long-term interagency participation.

While many agencies and disciplines participate in shared systems, each participant has different requirements. Allowing for varying levels of participation provides the flexibility needed to meet these differing needs in a manner that is equitable to all the participants. Levels of membership in a shared system are described in terms that include the size of the agency and its potential impact on system loading, the number of member agency users, whether or not the member agency owns and operates infrastructure elements, and the extent to which this infrastructure will be integrated into the shared systems (e.g., partial or full). The financial responsibilities of the system partner are consistent with the terms of its level of participation. Terms such as client member, integrated member, cooperating member, associated member, and commercial member are used to reflect the varying degrees of participation and responsibility of participating members. Several potential partnerships were identified as follows:

- **Public works agencies as participants:** In some instances, public works agencies are included as members of public safety shared systems. Often agreements that allow public works participation are brokered because some public works groups assume public safety roles and responsibilities during times of crisis and need (e.g., trash removal organizations being responsible for deploying their trucks to plow snow during heavy winter storms). In some cases, important public safety and public work functions are organized under one agency and their separation as members and non-members on a shared system is not practical. Generally, the public safety-related requirements of public works agencies are light and intermittent compared to those of the primary system users.

- **Other local agencies as participants:** In addition to public works agencies, many other local entities may make good partners for shared system development. For instance, small local airports may have the need for emergency services in times of air disasters, and school districts have public safety responsibilities during school emergencies and weather-related evacuations. Additionally, private toll road operators, parks and recreation departments, and private ambulance services may become subscribers and, through their participation, reduce the cost when implementing a shared system.

- **Federal agencies as participants:** In selective regions, federal agencies are joining in shared systems on a limited but sustaining basis. These arrangements stem from the

jurisdiction (e.g., private ambulance service companies). These types of private organizations are often included as partners in shared systems. As with other partnership agreements, those that govern the relationships with these affiliated organizations are scaled in a manner that is appropriate to their usage needs.

- **Private companies as partners:** Private sector groups, such as utility companies or telecommunications firms, are becoming increasingly popular partners in shared systems. The organizations typically bring existing radio resources to the partnership, or have similar operational requirements for radio communications.

**Partnership Models**

Increasingly, formal partnership agreements are being executed. These agreements allow for differing degrees of participation, responsibility, and use of one radio system. In general, three working models of partnership agreements have been identified. These include:

- **Public partnerships:** Public partnerships entail cooperation among government entities. Under this scheme, participating agencies incur lower initial costs, require smaller capital investment, and save money through purchasing by volume. Government owned and operated statewide systems typically rely on the public partnership model, as do systems shared among multiple local jurisdictions. Small agencies often benefit from partnerships with large or well-funded agencies by obtaining modern technology and services not otherwise affordable. In partnerships with multiple agencies, there are often tiered levels of participation to accommodate different user needs. A number of partnerships between state and federal agencies are also beginning to develop. Regulatory and procedural barriers between the National Telecommunications and Information Administration (NTIA) and the Federal Communications Commission (FCC) need to be addressed.

- **Partnerships between public safety agencies and utility companies:** Power and utility companies often partner with public safety agencies because they provide reliable infrastructures, offer interconnection capabilities, and have similar coverage requirements. Partnerships with utilities often allow for inclusion of agencies that cannot afford to upgrade equipment or incur infrastructure costs. Utility companies are often willing partners since their infrastructure and interconnective capabilities do not require major restructuring to accommodate public safety radio communications. Public safety agencies can frequently join a system that is already built and thus avoid

emergencies, accepting operational decisions made jointly by all users, and providing appropriate systems security. FCC regulations governing the use of common channels between public safety entities and utilities is also an important consideration in coordinating utility partnerships.

- **Partnerships with a private/commercial entity:** Partnerships with private organizations, such as specialized mobile radio service providers or the majority owner of radio sites in an area, are another alternative. The private entities often bring significant capital investment to the partnership, alleviating cost pressures associated with infrastructure construction, site acquisition, licensing, and maintenance. Additional benefits include a reduction in the amount of manpower needed to develop a system and the use of better technology without the requirement for a major system upgrade. Common issues with this type of partnership include obtaining additional frequencies, guaranteeing a limited volume of communications, ensuring channel availability, and providing the necessary security. Another potential issue is that private/commercial entities usually operate where it is economically viable. This may leave portions of a jurisdiction uncovered. Partnerships between public and private organizations must conform to the laws and policies governing the public safety entity, which may influence network management, procurement, and financing.

**Financial Responsibilities in Partnerships**

In formalizing partnership agreements, financial responsibilities and payment arrangements must be established to spread the costs of implementing and maintaining a shared system. In most cases, it is best if the system implementation does not begin until the monetary/payment structures are established. Common payment structures in partnerships include:

- Fees based on each member's percentage of usage.
- Flat rate fees based on the number of users for a given member.
- One-time access fees.
- Monthly and annual fees.

**Common Problems Associated with Partnerships**

While partnerships allow participating agencies to leverage their resources, there are common problems associated with partnerships that need to be addressed:

increased traffic and loading that will be incurred as a result. In time, adjustments to system capabilities may be required to accommodate the increased loads.

- **Talk Groups:** System administrators need to manage queuing and the number and size of talk groups, especially in the early stages of system operations, to avoid excessive reprogramming. Suggestions for doing so include running statistical reports on talk group usage to weed out unused groups, giving agencies test radios before coming onto the system, establishing a hierarchy of priority groups, and discussing talk group designs directly with users. It is frequently the case that a system starts out with a large number of talk groups. In general, this number is gradually reduced as actual usage needs and patterns are identified.

- **Regulations:** Partnerships with private entities or non-public safety organizations are complicated by a variety of regulatory issues that must be addressed. For example, these partnerships need to comply with all FCC regulations for public safety frequencies. Waivers need to be obtained to allow for joint use. Additionally, a host of complicated regulatory issues can arise. Project managers need to have good legal support and work diligently and creatively to overcome regulatory hurdles.

## HIGH LEVEL APPROACHES FOR SHARED SYSTEM DEVELOPMENT

Three general approaches for providing multi-discipline, multi-jurisdictional shared systems emerged from the various presentations. These approaches are:

- **"Buy Your Own":** Under this scheme, the participating jurisdictions and public safety agencies come together in a formalized way to pool their resources to build, operate, and maintain a shared radio communications infrastructure that is "owned" jointly by the system partners. Generally this approach flows from high-level political and programmatic commitments, with significant "grass roots" support from radio managers and users.

- **Shared Ownership and Joint Operation:** The second approach is similar to the first in that agencies band together to share infrastructure owned and operated by public safety agencies. However, they do so in a less formalized manner. Participating agencies share their existing infrastructures and devise schemes for joint management and operation. This approach hinges more on agreements and coordination among radio managers and the like than on high-level political leadership or formalized partnership agreements among

provides its service under a known fee structure and the participating user organizations band together to obtain a "best value" rate. Under this approach, the participating user agencies do not own or operate the infrastructure. Therefore, they do not engage in capital-intensive infrastructure modernization efforts. Rather, through the joint use of third-party infrastructure, the participating agencies essentially create a leased shared system to serve their purposes.

## SYSTEM CONCEPT EVOLUTION AND DEVELOPMENT TIME LINE

While there are variations across systems, a common framework characterizes system definition and development efforts. The framework consists of a set of common steps:

- **Preliminary studies** that identify the need for change in general terms (these studies can take up to a year to complete, are often performed by outside consultants, and can precipitate action immediately upon completion or some time later).

- **Requirements analyses** that formalize the need as statements of desired functionality (these analyses typically take a year to complete, are often done by outside consultants, and are usually followed closely by implementation planning efforts).

- **Implementation planning** that includes identifying funding sources and that results in the systems concept, development schedule, and high-level design objectives (implementation planning can take one-to-two years, is done in close coordination with key stakeholders, and usually includes support from an outside consultant).

- **Pre-proposal activities** that include the preparation of proposal development packages (pre-proposal activities, which can take six to nine months depending on the number of Requests For Information (RFI) and the complexity of the Request For Proposals (RFP), are performed by a government agency as project executive and a project team that usually includes consultants).

- **Proposal development and evaluation** under an RFP process or its equivalent (proposal development is performed by the responding vendors and takes place typically over a three-month period, while proposal evaluation is performed by the government and its team typically over a 30-to-60 day period).

- **Preliminary Studies:** In most instances, preliminary studies performed three-to-five years ago revealed the need for significant improvements to existing radio communications systems. In several cases, the studies were sponsored by task forces, information technology executive agencies within governments, or major radio systems users, such as the state police. Benchmarking against national best practices was sometimes included as an element of this step. These preliminary studies were not intended as full requirement assessments but rather as means for developing a more structured understanding of the problem. In general, they established the clear need for change. Often these analyses resulted in recommended plans of action, the first step of which was typically a formal and thorough requirements study.

- **Requirements Analyses:** User needs and the operational concerns of radio managers were established through surveys, audits, or other equivalent mechanisms. This information formed the basis for the systems requirements that led to the pursuit of shared systems designs. The requirements were captured in a formal manner and spoke to addressing current deficiencies, as well as to providing additional services enabled by new technologies. Requirements were often gathered by individual user groups and then assembled into a comprehensive volume. The history and background regarding existing systems, and the extent to which these systems have met user requirements, was gathered as well. With requirements firmly established, and with the limitations of the existing systems understood relative to these requirements, more detailed system planning was possible and appropriate.

- **Implementation Planning:** The beginning of a multi-year shared systems implementation effort was generally signaled with the creation of an implementation plan or its equivalent. The purpose of the plan is to lay out the systems concepts, goals, objectives, high-level design considerations and profiles, and resource requirements. For shared systems, implementation planning also included formalizing the ground rules for cooperation and partnership among participating jurisdictions and disciplines. The implementation plan signaled the transition from the studies and analyses phase of the effort, to the solution development and deployment phase. The implementation plan was typically the document that went before senior decision makers and budget analysts to make the case for resource commitments and to establish project schedules. Resource decisions made at this stage often reduce the scope of the development effort, curtail the number of requirements supported, and

potential vendors. Public safety entities are beginning to use RFIs to encourage innovative vendor solutions and identify potential vendor partnerships. The RFI is followed by the preparation and issuance of an RFP. The RFP specifies technical design and cost parameters. A trend among RFPs for shared systems has been an increase in the degree of requirements and performance specificity, as a mechanism for avoiding under-performance problems experienced by some of the early shared systems.

- **Proposal Development and Evaluation:** Vendors prepared proposal packages in accordance with the published RFP. The proposals were evaluated and assessed relative to one another based on several dimensions: the extent to which requirements would be met; the technical accuracy of the design; the cost implications (both up-front and recurring); the operational implications of the design; the implications for maintenance; etc. Proposals were evaluated and scored, usually with the assistance of an outside consultancy. Often vendors were asked to provide clarifications, re-address certain requirements, or make other modifications that resulted in more responsive proposals.

- **Source Selection and Deployment:** Proposal evaluation culminated with the selection of a specific vendor, or vendor team, and the technical design that was advanced in the corresponding proposal. Detailed negotiations ensued to formalize the source selection and deployment agreement through an appropriate contract mechanism. The vendor then proceeded with more detailed system design, followed by system build-out, test, and initial operation until system acceptance was made.

## CRITICAL SUCCESS FACTORS FOR SHARED SYSTEM DEVELOPMENT

Several critical success factors have been identified in the shared systems approach. A general consensus regarding the best overall approach emerged—it is one that combines effective top-down strategies (to build senior decision-maker support) with strong "grass roots" initiatives (to establish and sustain support among radio managers and users). The specific critical success factors included:

- Approaching the system design from a customer/user perspective;

- Committing to long-term interagency partnerships by opening the system up to all

- Developing detailed system designs and specifications by clearly defining operational needs and requirements with the vendor and participating agencies;

- Endorsing the mission uniqueness of agencies by accommodating agency-specific requirements and ensuring the necessary autonomy through concerted network management;

- Recognizing and pursuing cost advantages of joint service agreements or of building joint systems (achieving certain economies that are not available to smaller, single-agency, single-jurisdiction systems);

- Training participating users to handle and use the equipment correctly, and ensuring that training actually occurs;

- Organizing and energizing core, high-stake users to engage in strong "grass roots" education and, where appropriate, lobbying efforts to increase citizen awareness and senior-level political support;

- Leveraging off of concern on the part of radio managers and users that if they did not join in the shared system they would have diminishing support and resources for maintaining their own systems;

- Developing, encouraging, and capitalizing upon strong user support for change, and for systems that provide a more capable suite of services in a manner that is more seamless than is currently the case;

- Maintaining a good working relationship with the vendor and establishing clearly identified and specified goals and requirements that the vendor must achieve;

- Establishing and maintaining strong administrative support at the highest levels of government involved (e.g., from the Governor for statewide systems, from county board chairpersons for multi-county systems) to champion the system through the legislative process and through local zoning and approval hearings;

- Building and leveraging strong support from state legislatures through the passage of enabling legislation and the establishment of sustainable sources of funding (e.g., radio

- Securing long-term and ongoing funding mechanisms that will endure throughout the planning, implementation, and maintenance stages of the system;

- Addressing regulatory, licensing, and coordination issues, (e.g., tower construction and zoning obstructions, spectrum allocation, and partnership agreements);

- Recognizing and highlighting the compelling need for improvements to poor and, in some instances, dilapidated radio communications infrastructure, with problems that include inadequate maintenance, poor coverage, increased channel congestion, growing interference, limited services, and structurally damaged towers;

- Accommodating FCC licensing deadlines (i.e., with expiration dates looming on certain licenses, agencies were compelled to jointly move out on development and implementation efforts);

- Developing common operational procedures among the partners ensuring that radios are programmed properly and a common "language" is used by all of the different partners on the system;

- Keeping the lines of communication open among all of the partners on the shared system;

- Defining partnership responsibilities. Successful shared systems require partners to be responsible for their portion of the system and to work together to ensure the system is properly licensed and operated within FCC rules. Certain shared systems arrangements require that partners give at least a one-year notice before exiting the shared system;

- Establishing a standardized fee structure for subscribers to the system; and

- Developing a detailed Memorandum of Understanding (MOU) that describes the purpose and intent of the shared system, defines the users, defines the owner/operator responsibilities, creates a governing board, establishes methods of interoperability, sets the subscriber fee structure, and ensures that all partners on the system are treated equally.

**Unsuccessful Arguments for Change**

routine good-government practice and not a matter of merit or a selling point for a new concept).

- **High Maintenance Costs:** Highlighting the high maintenance costs associated with the existing systems (the general view of decision makers here being that this is an operating reality that agencies created for themselves as a result of earlier procurements—it is a routine part of doing business for those agencies and, as such, does not merit special treatment).

- **Frequency Refarming:** Discussing the consequences of FCC frequency refarming, which necessitates the more efficient use (and reuse) of limited spectrum (e.g., through shared systems) (it is difficult to establish enough understanding among decision makers and other high-level stakeholders regarding such focused, technical issues to make these issues compel support or action).

- **Centralization:** Emphasizing the benefits of centralized system design, procurement, operations, maintenance, etc. (in an era of "devolving" responsibilities to the most fundamental levels of government, the centralization argument holds little sway).

**Successful "Tools" for Change**

Successful arguments for change require a concerted follow-through effort that is enabled, in part, through certain mechanisms resident in the "tool kit" of shared systems developers. These mechanisms include:

- **Creating**, through executive or legislative action, governing boards, steering committees, or management councils with sufficient authority to advance the development of a system and to manage and operate it going forward. Representation on the governing board should be defined in advance and the roles and responsibilities of each member should be clearly stated.

- **Obtaining dedicated full-time resources** (e.g., systems engineers, budget analysts) at the appropriate levels to ensure effective handling of key issues (e.g., performing design reviews, addressing funding requirements). These full-time resources do not necessarily translate to full-time equivalent staff.

- **Obtaining letters from senior government officials endorsing the system** and its

- **Making well developed and consistent presentations** to important existing and potential stakeholders, including the use of professional quality videos that help obtain and maintain buy in from the government executives, legislatures, the citizenry, and other key stakeholders.

- **Establishing a standing public relations and outreach program** that uses communiqués (such as newsletters), provides brochures to describe system benefits, leverages favorable press in trade journals and local newspapers, and makes use of other mechanisms (e.g., conferences and symposiums).

## SENIOR EXECUTIVE PERSPECTIVE

It is often actions and decisions taken by senior executives within government that are critical to the successful development and long-term operation of radio communications systems. The following items were cited by senior executives as major challenges to shared systems development:

- **Building support from politicians:** Interest among elected officials needs to be raised through a variety of avenues. It was suggested that elected officials need to first be persuaded that the issue is directly related to the public's safety. Building the political impetus can be facilitated through the use of the media, as well as by grassroots efforts by user associations to lobby their local legislative representatives. Ultimately, support is often garnered through high-level, persistent "politicking" and advocacy by senior executives. Feasibility studies are also important in conveying the concept of shared systems to politicians.

- **Establish relationship with fiscal analysts:** Budget and financial analysts can be important allies in acquiring or upgrading systems. These people can provide advice on budget submittals and key items to include in proposals, as well as guidance and education on a jurisdiction's funding processes. This information can help agencies coordinate their funding cycles so that they request and receive funding at the appropriate times.

- **Gaining cooperation from other public safety entities:** The safety of field

- **Maintaining trust with partners:** Trust must be established by involving all participants in a shared system development project from the beginning of the process. The advantages of sharing will eventually overcome skepticism and concerns regarding control. Additionally, open and frequent communication among partners is essential. Multiple committees of colleagues (e.g., chiefs, managers, technicians, users) can be used to facilitate joint decision making and maintain personal contact between participating entities.

- **Keeping the focus on service delivery:** Focus on service delivery must be maintained by keeping MOUs or contracts between participating agencies as flexible as possible. Agreements that require complicated measurements or formulas for participation arrangements can get the shared system off track. The advantage of focusing on service delivery is that the shared communications system becomes transparent to customers and users.

- **Working with vendors to meet public safety needs:** A common dilemma for senior executives is radio communications vendors who are not responsive to public safety needs. Public safety entities need to be able to drive the marketplace so that vendors will partner with public safety to develop solutions to the interoperability problems. Vendors need to be convinced that public safety is no longer interested in proprietary systems that will not adapt to an open architecture environment.

- **Brokering communications between users and technical staff:** Open and frank communication between operational and technical personnel is imperative for a system that meets the needs of the users. Senior executives must establish mechanisms for the two groups to work together so that systems that are purchased, built, and implemented are both operationally and technically sound.

## USER PERSPECTIVE AND MISSION OPERATIONS

It is commonly understood that reliable and effective communications are of uppermost importance to system users. In bringing the public safety community together, the PSWN Program has been in the position to gather insights into the perspectives of system users and their mission requirements. The following illustrate the particular needs of the field personnel in the public safety community.

- To possess enough radio equipment for all field personnel, especially hand-held radios that are lightweight, reliable, and provide full coverage over an entire jurisdiction;

- To have access to commercial services (e.g., cellular, paging, CDPD) that enhance capacity and provide additional capabilities to complement their land mobile radio (LMR) “lifeline”;

- To have protected communications to preclude monitoring by the criminal element;

- To possess simple and usable radios that require minimal training and a limited number of features;

- To possess equipment that is practical to install, interactive with other data systems, and compatible with both current and future technologies;

- To possess durable radios that can withstand the stress of the field environment (e.g., water and heat) and are easy to maintain;

- To have portable radios that meet the basic and special communications needs of firefighters at the site of the fire;

- To have a high percentage of in-building coverage (particularly for fire fighters);

- To apply technology to enhance safety features of radios (e.g., signaling of locations for accountability of personnel);

- To allow the media to monitor public safety communications;

- To have the funding to purchase reliable and compatible radio equipment; and

- To have the training and education needed to be comfortable with, and efficiently use, the agencies’ radio communications system.

**User Perspective on Interoperability**

Several users commented on their view of interoperability requirements for public safety

- To have and test detailed emergency plans on an annual basis so that public safety agencies are prepared to coordinate at the time of disaster;

- To share information and resources to handle special events;

- To have the ability to receive information from other public safety entities before coming into an incident or arriving on scene;

- To move away from using multiple radios and possess a single radio that would allow communications with other public safety entities coming from and operating within another jurisdiction;

- To have only one antenna per vehicle in the field;

- To have a multi-band, multi-mode radio that can switch itself between voice and data in a manner similar to the landline Integrated Services Digital Network (ISDN) functionality;

- To have as many channels as needed to handle emergency communications at an incident site;

- To have the ability to have priority access to a specified channel during emergencies or incident response;

- To be asked to provide feedback on operational requirements and problems to radio managers and technicians;

- To have the ability to interface their communications system to systems in surrounding jurisdictions (interfacing is especially important when other systems use disparate frequency bands or proprietary technology);

- To have a common channel for communications between local, state, and federal agencies;

- To increase management's understanding of communications and the funding needed to support interoperable systems;

**User Perspective on Mutual Aid Operations**

Several users and dispatchers identified operational challenges that occur during mutual aid operations. These challenges range from unfamiliarity caused by limited day-to-day mutual aid operations to difficulty in accessing mutual aid channels on radios. Cross-patching, a potential solution, also becomes a problem during mutual aid events because of the number of radio channels it takes to set up a patch and the fact that patches to trunked systems talk groups do not always work correctly.

Users also suggested various steps that would improve their ability to perform during mutual aid operations:

- Developing policies and procedures that accurately describe operations during mutual aid situations and establishing a single answering point for mutual aid calls;
- Developing a standard naming convention for all mutual aid channels so that dispatchers from different jurisdictions can efficiently put people on the same channels and direct communications during mutual aid situations;
- Using plain language on interoperability channels during mutual aid operations;
- Ensuring consistent training and practice for mutual aid operations so that public safety personnel know how to perform in mutual aid situations (this training comes at a cost; some agencies are developing self-paced CD-ROMs or training dispatchers during their shifts on how to respond to mutual aid calls);
- Using standard locations for mutual aid channels on radios to enable users to change quickly to mutual aid channels (in one example, a public safety official had to click the radio 14 times to get to the mutual aid channel);
- Developing consolidated dispatch centers to improve person-to-person, and thus agency-to-agency, coordination during mutual aid events; and
- Finding ways to use technology to improve mutual aid efficiency and reduce its reliance on human interfaces.

During a one-man, two-state crime spree in which two law enforcement officers, a judge, and others were murdered, responding law enforcement officers encountered serious communications deficiencies. In the aftermath of the incident, many valuable lessons relating to the lack of interoperability of public safety communications came to light. Several lessons can be learned from this tragedy, including:

- Dead spots in coverage precluded complete messages from being received by law enforcement officers and dispatchers;

- Hand-held radios, in service for approximately a year, were not used effectively due to a lack of training (e.g., officers had difficulty identifying which channel to use to talk with officers from other jurisdictions); and

- Too few agencies were able to use common frequencies so responding officers had little interoperability when jurisdictional lines were crossed.

**Incident Presentation (Florida Forest Fire)**

During a five-week period in the summer of 1998, 6,500 firefighters from local, state, and federal agencies converged on Florida to fight 2,214 separate brush fires across the state. A variety of radio communications problems emerged over the course of the emergency. A lack of interoperability severely hampered efforts to sustain a coordinated response to the disaster. There were also a limited number of channels available that limited the responsiveness of the public safety entities. Operational impacts included:

- Firefighters at the same site, but from different agencies, could not communicate with each other. Local, state, and federal firefighters used a variety of communications systems (analog, digital, conventional, and trunked) and operated in different radio frequency bands (VHF, UHF, 800 MHz). In one instance, federal agencies received directions to evacuate based on shifting wind conditions, but were not able to relay this critical message to their state and local counterparts at the scene.
- Many agencies had to rely on “loaning” hand-held radios to other agencies to facilitate joint operations.

- Aerial drops from federally operated aircraft were delayed due to a lack of direct radio communications with local agencies on the ground. Instead, messages were relayed through dispatchers, causing undue delays.

mandated that although Advanced Life Support (ALS) providers had recently upgraded to a statewide 800 MHz system, they should also retain their VHF radios for coordination during disasters. While the radios were available in the vehicles, they often had not been maintained or personnel did not know how to operate them.

- The volume of calls due to smoke and fire sightings caused the local 911 lines to be constantly overloaded. The surge of calls overwhelmed routine dispatch resources.

- Police and other law enforcement agencies did not share the 800 MHz National Calling Channels.
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- The lack of a uniform national plan prevented additional coordination.

Lessons learned from the Florida fires include:

- Better communication planning is needed to prepare for large scale emergency response involving multiple agencies and disparate communication systems;

- With multiple agencies involved, communication procedures need to be revised as soon as possible to facilitate coordination with and among field personnel;
- Agreement on a statewide radio platform is needed, including what types of systems should be allowed, so that local and state agencies can interoperate;

- Extra portable equipment (radios and batteries) is useful for maintaining communication with and among field personnel;

- As the same term may mean different things to different public safety agencies, it is important to establish a standard vocabulary for agencies that require interoperability during public safety emergencies; and

- Never forgetting how the private sector can be pulled in to help during a mutual aid emergency. For example, during the fires, concrete-mixing trucks acted as tankers by hauling extra water to fire sites.

Since the 1998 forest fires, the State of Florida has implemented an action plan to prepare for future emergencies. Among the basic tenets of the plan are the uses of nonproprietary

the site of a large incident. The state has also begun to fund a pilot project to link the state's 800 MHz radio system to the VHF mutual aid system to improve the communications between firefighters and other public safety officials.

**Incident Presentation (Oklahoma City Bombing)**

Immediately after the bombing of the Alfred R. Murrah Building in Oklahoma City, radio communications were the principal means to coordinate the disaster response and concurrent criminal investigation. Radio communications between agencies quickly became a significant problem. The communications issues encountered included:

- There were not enough channels available to handle the public safety radio communications. The four primary VHF radio channels used by Oklahoma City Police Department became instantly congested after the explosion as officers throughout the city felt the blast and reported the incident. Further communications with the first officers on scene were hampered by the overwhelming volume of traffic. One of the two Oklahoma City Fire Department radio channels was used by the rescuers on scene. The other channel was extremely congested as it was used to coordinate mutual aid fire coverage for the entire city throughout the disaster response period.

- Because all voice channels were busy, initial communication with the command post had to take place over a cellular phone link. Later that day, the command post was equipped with mobile data terminals (MDT) that operate on a dedicated, private, 800 MHz channel. With congested voice channels, MDT messaging became the only reliable means of communication with the command post at the scene.

- Oklahoma City police and fire departments operated separate communication systems and utilized different frequencies, precluding interoperable voice communications. However, all police and fire units were equipped with an MDT. MDTs therefore provided a vital communication link between police and fire units throughout the entire incident.

- One hundred seventeen agencies, each with separate radio systems, responded to the incident, providing more than 1,500 personnel. Because responding agencies could not communicate with each other, runners were used to relay messages .

- Hundreds of cellular phones were provided to commanding officers at the scene to aid

users and disaster recovery activity. The responsiveness of the public safety entities was hampered by the limited availability of spectrum and the lack of interoperability.

**Incident Presentation (Arizona Train Derailment)**

An AMTRAK train derailment, resulting from domestic terrorism/sabotage, occurred in a remote corner of Maricopa County, AZ during the Winter of 1995. Nearly 100 passengers and crew were injured, including one fatality. The emergency response, involving more than ten agencies from surrounding jurisdictions, was hampered by a number of communications problems:

- Responding agencies, including several fire and rescue departments, emergency medical services agencies, the sheriff's department, the transportation department, and public works department, used disparate radio systems. Each organization could communicate with their respective dispatch, but could not communicate directly with other agencies on scene.

- The incident site was located more than seven miles from the nearest road and was in a 50-foot ravine. The terrain created radio coverage problems as rescue workers in the ravine were unable to communicate via their radios with personnel on the rim of the ravine.

- Radios in the rescue helicopters became the primary means of coordinating the actions of rescue personnel on the ground. However, when the helicopters left the incident site to transport the injured, coordinated communications were lost.

- Responding agencies set up two separate triage facilities at opposite ends of the ravine, unknown to each other due to a lack of coordinated communications.

- Cellular phones were an unreliable backup to radio communication. As soon as the media arrived on the scene, all cellular calls were blocked.

In the aftermath of the incident, Maricopa County created an Inter-Agency Communications Committee to explore ways to improve interoperability among responding agencies. Issues discussed included:

- The need for funding to migrate all county agencies to the same type of radio equipment.

- The need to overcome traditional institutional boundaries, share ownership of the communications system, and be willing to work together.

**Incident Presentation (Boston Fire Department)**

Two separate incidents were discussed in which Boston firefighters had become trapped in burning buildings during structural fires. One of the two incidents resulted in a loss of life. Audio tapes of the radio traffic that occurred during both incidents were played. Several points were made regarding the circumstances surrounding the incidents and the part that the lack of communications played in endangering personnel safety. These points included:

- Every firefighter should be provided with a portable radio so that they can communicate during an emergency;

- More channels are needed to support operational communications at the site of a fire. When emergency transmissions are "stepped on" due to system congestion, messages cannot be delivered and lives can be lost;

- A lack of adequate in-building coverage can prevent reception of critical communications between firefighters in the field;

- Firefighters from different companies who respond to incidents have limited interoperability; and

- A mobile command post can help improve fire ground communications and resolve some of the interoperability problems. However, a substantial amount of time is required to make a mobile command post operational. Mobile command posts generally only support multiple alarm fires.

**Incident Presentation (Columbine High School Shootings – Littleton, Colorado)**

During a rapid killing spree at a Columbine High School in Littleton, CO, two teenage gunmen opened fire on teachers, administrators, and their classmates, killing 15 people (including themselves) and causing $150 million in damage to the school. The students were armed with semiautomatic weapons and a variety of explosives, and intended to inflict serious damage on the

personnel from a variety of public safety agencies including police (approximately 28 agencies), fire (10 apparatus), EMS (48 units and 2 air ambulances), bomb squads, SWAT teams, and the FBI responded to the incident. Several communications and interoperability challenges were introduced into the situation. These challenges included the following:

- During the initial response, three partial SWAT teams (Jefferson County, Littleton, and Denver) arrived on the scene. One agency communicated on 800 MHz and the other two were on different VHF frequencies. The teams used hand signals to communicate within the building.

- Law enforcement needed to create a perimeter around the school, but the area was so large they needed to use officers from multiple jurisdictions who could not communicate because they were on different frequencies.

- All commercial communications services were being used simultaneously. As soon as the event began, it was impossible to make a cellular phone call.

Responding public safety agencies addressed these challenges in the following ways:

- Dividing the SWAT teams so that members from each jurisdiction were on each team. This arrangement ensured that each team was able to communicate with the other's when appropriate.

- The incident commander assigned specific duties to each agency to ensure communications about that activity could be completed without problems. For instance, the State Patrol handled traffic issues, and the Arapahoe County Sheriff handled student transportation away from the scene. A senior member of these departments was kept at the command post so there would be "interoperability" among efforts.

Following the incident at the high school, local authorities identified several recommendations that could improve responses to similar situations in the future. These recommendations include:

- Establishing a regional communications plan;

- Establishing working relationships among hospitals, fire/EMS, schools, and local law

- Taking care of responding officers (e.g., relieving crews in the field, counseling, and doing what the leader feels is right).

**Incident Presentation (Hurricane Floyd – North Carolina)**

In fall 1999, the State of North Carolina was hit by a series of hurricanes. The most devastating was Hurricane Floyd. This storm brought 10–20 inches of rain to large portions of the state, causing mass flooding, widespread loss of agriculture and livestock, and significant destruction to the state's transportation and communications infrastructure. Public safety agencies from within and outside the state mounted a tremendous response to the disaster.

North Carolina's emergency response involved officials from the state patrol, community corrections, the Department of Motor Vehicles, marine and fishing resources, and the National Guard. Emergency management teams from five different states also provided support. With all these different entities responding to the crisis, communications problems soared. The state learned the following lessons about how to respond to large-scale disasters:

- Avoid relying on land-based systems to connect wireless systems because in great disasters, the land-based telephone system is frequently unavailable; instead, consider using microwave (or other wireless connections);

- Have staff trained to operate and maintain the radio system because contractors may not be available to help bring the system back up following a disaster; and

- Remember the fatigue factor and relieve personnel who have been in the field.

## SYSTEM REQUIREMENTS AND CAPABILITIES

The user perspectives on mission requirements discussed above illustrate many needs of the field personnel in the public safety community. These needs can be tied to user requirements for their communications systems. Understanding these requirements and designing systems with the capabilities to meet these requirements are critical first steps in implementing successful systems. Requirements that are common to systems projects include:

- Seamless communications while roaming over great distances;

- Support for end-user equipment that includes hand-held radios, vehicle-mounted mobile radios, and mobile data terminals that are vehicle mounted, but can be removed for use in other environments;

- Significant in-building radio communications;

- Ability to accommodate peak usage needs;

- Backwards compatibility with existing technology; and

- Interoperability between all bands being used by public safety in the municipality, state, or region using various network interfaces (Note: Use of various network interfaces provides interoperability, not a "shared" system).

In any systems development effort it is critical that the final system capabilities meet as many of the requirements as possible to sustain or improve mission performance. The process of meeting baseline requirements becomes more complicated as public safety agencies move to shared environments. In a shared environment agencies must balance the general system requirements that are standard among all the system participants with those agency-specific requirements that are unique to specific participants. The resulting system capabilities need to reflect a balance agreeable to all participants. Successful shared system implementations are those that can best limit the gap between participating agencies requirements and the capabilities of the system.

**Best Practices for Defining System Requirements**

Agencies' requirements need to be identified early in the process. The following item was cited as a key enabler of success:

- **Include interoperability requirements into RFPs:** The State of Colorado included a requirement for an access channel to the VHF, UHF, and 800 MHz bands into their RFP. The 800 MHz trunked system will have a dedicated talkgroup to access the VHF and UHF channels.

## STANDARDS AND TECHNOLOGY

A number of items were cited as the drivers behind the need for standards-based systems:

- To achieve a minimum threshold of uniformity among public safety agencies' communications capabilities;
- To allow for interconnection between disparate communications systems without degradation of service;
- To allow the most direct communications interoperability;
- To enhance migration efforts to new technologies and ensure backwards compatibility with legacy equipment;
- To allow for the portability and compatibility of digital end-user equipment;
- To foster a partnership with industry and create a more competitive marketplace for both infrastructure and end-user equipment;
- To provide the availability to add "nodes," or expand the network, in an efficient manner;
- To promote price competition and competitive procurements over the life cycle of the system;
- To reduce the costs of having multiple radios to distribute during situations that require interoperability;
- To satisfy diverse missions within a department or force;
- To encourage participation in shared systems and group purchasing over time;
- To spur innovation and creativity for new equipment, features, and functionality; and
- To address the recommendations that the new Public Safety National Coordination Committee (NCC) may make regarding standardized public safety communications

- Standards compliance does not mean standards compatibility. Vendors can interpret standards different ways and still make equipment that is incompatible.

- Creating a technical standard does not necessarily solve interoperability. Several operational issues (e.g., channel management, key code setup) have to be worked out among participants on the shared system. Often times, resolution of these problems is more difficult.

**Creating Standards**

The American National Standards Institute (ANSI) oversees the standards development process and makes sure it is a fair and open process throughout. ANSI standards are not solely industry driven or user driven, but instead involve all of the interested parties. This ensures that each of the groups' interests are taken into account. Furthermore, ANSI requires a majority of the parties to approve a standard, which means a consensus position must be reached before a standard is official.

ANSI oversees the work of standards development organizations such as the Telecommunications Industry Association (TIA). The TIA, and organizations with similar functions, develop standards to address compatibility, interoperability, and compliance. These bodies generally include industry members, technology developers, engineers, and specifications experts. It is critical that standards development organizations include the members of industry so that the most fair and compatible standards are developed.

The standards development process is not simple or short. There are several reasons that explain why it takes so long to develop standards:

- Competitive interests among vendors that prohibit significant movement towards any standard.

- The availability of varied technologies has resulted in the public safety community adopting an array of available technologies provided by various vendors.

- Because the technology is complex, it takes time to sort through the details of each solution.

- Standards must be clear and concise and not left to interpretation. Vague standards can cause new interoperability problems, or continue the same problems that were in existence before the standards were made.

**Current and Developing Standards**

**Project 25:** Project 25 is a cooperative effort between Telecommunications Industry Association (TIA) and the Electronic Industries Alliance (EIA). Its goal is to develop a suite of standards for digital LMR equipment. The standards are designed to be scalable from the very largest systems to the smallest. Project 25 is currently the only set of standards available in the United States. Progress was reported on several key Project 25 standards including the Common Air Interface (CAI) standard, which allows equipment from one system to interface with equipment in different systems, the Vocoder, and the standard for the trunking control channel, which has been set at 9600 bps.

The suite of standards also includes standards for encryption, which were created to address Federal Government needs. The standards allow the whole network to be encrypted and are designed to meet any new Federal requirements.

Project 25 standards are being developed in two phases. Phase I focuses on developing standards for Frequency Division Multiple Access (FDMA) technologies, whereas Phase II focuses on developing standards for both FDMA and two- and four-slot Time Division Multiple Access (TDMA). Phase II has several objectives. These objectives, which define the attributes of a Phase II Project 25 system, include developing standardized technology, enabling interoperability, ensuring spectrum efficiency, delivering a compliant FDMA CAI, allowing use in different frequency bands, and having a technology that can be licensed under fair and reasonable conditions. The infrastructure cost for Project 25 systems will vary after Phase II because the costs will depend on the technology selected (FDMA or TDMA).

The Project-25 standards are being developed using expertise drawn from various sources—TIA, the European Telecommunications Standards Institute (ETSI), public safety users (who have an open voting committee), and manufacturers. The process is governed by a steering committee. The suite of standards is currently available on CD-ROM.

**TETRA:** The Terrestrial Trunked Radio Access (TETRA) standard is popular in Europe. It has not taken a firm hold in America for at least three reasons. First, the standards process in the United States is more deliberate than in Europe. For example, the TETRA standard

The issue of whether standards should be mandated to promote interoperability yielded several points-of-view:

- There should be a basic or minimum set of standards mandated to which all systems must adhere. The federal government should take the lead in establishing this basic standard, with involvement of local, state, and regional user groups and the equipment manufacturers.

- There must be a common baseline standard for the air interface in all public safety bands. This is essential for interoperability.

- There should also be a basic network interface. It was noted that the cellular market had a network standard (NC-41) that allowed three different technologies (CDMA, AMPS, and TDMA) to interface into the cellular network.

- A standard should be established but not mandated. Agency implementation based on that standard should be voluntary. An interoperable system based on standards may not be financially feasible or even desirable for some public safety agencies. Individual agencies should be able to identify the level and type of interoperability they require and can afford, and choose not to adopt standards that provide capabilities beyond their needs.

**Public Safety Community's Actions**

The public safety community can have a significant influence in the standards development process. The following options were presented as actions the community can take to be involved in the standards setting process:

- Participate in standards development organizations such as TIA;

- Seek funding for the travel costs needed to participate in standards development organizations;

- Apply pressure on the FCC and Congress to mandate a standard for public safety communications systems; and

- **Software Programmable Radios:** The Naval Research Laboratory is developing this new technology. These radios accommodate a variety of waveforms, and the user can determine which "type" of radio he or she needs to use at a given time. The aim is to enable people to buy only one radio and then configure the radio's software to be compatible with all types of radios with which they would need to interoperate.

## IMPLEMENTATION PLANNING

In the planning stage, system implementation requires basic choices about all aspects of the system development process. A basic assessment of resources and personnel is essential in mapping out the best approach to system implementation.

### Approaches to Project Planning and Management

Five basic approaches to project management and engineering appear to be used by the entities responsible for the development of shared systems. The approaches vary according to the extent that the engineering management work is performed "in-house" by the responsible government agencies, is contracted out to consulting firms or systems integrators, or is left to the vendors themselves. The five approaches are described below.

- **Extensive in-house involvement:** This approach is possible only if the sponsoring government agencies have sufficient personnel with the appropriate skills and experiences. Agencies with a sufficient complement of such persons typically organize these persons in an engineering group that acts as an internal consultancy on technology matters. Irrespective of personnel considerations, this approach is usually pursued only when the sponsoring government agencies are willing to directly assume the risks associated with the project. Incorporating an outside firm within the project leadership team represents a means of risk sharing. This approach is more common when the system design and implementation are more routine and technically straightforward. This approach is less common as system complexity increases.

- **Partnership-based:** A variation of in-house management, this approach uses the combined systems integration strengths of participating agencies to plan all aspects of the project. This approach helps solidify bonds between the partners and provides a high degree of ownership in the system through the efforts of an inter-agency team of integrators.

required) while a consulting firm may act as the project manager, establishing detailed schedules and coordinating work efforts.

- **Minimal in-house involvement with extensive consulting support:** This approach is typical when the responsible government agencies have a minimal complement of technical personnel capable of managing in detail the entire program development and implementation effort. Under this approach, the government agencies are general managers of the effort and contractors provide all required project engineering and management functions. The contractor personnel form the "virtual staff" of the responsible government agencies.

- **Vendor provision of project management functions**. This approach is the closest to a pure "turnkey" approach whereby the selected vendor handles all aspects of the project, from beginning to end. Third-party consultants that can provide an independent view of project management and system development are not a part of the project team, typically because project complexity does not merit it, or because the project resources cannot sustain third-party contractor involvement. Panelists stressed that these arrangements must be carefully managed through a well-written contract to produce expected results.

**Best Practices for Implementation Planning**

A seamless implementation and system transition can occur if the users, vendors, and contractors are properly managed. The following items were cited as key enablers for success:

**Users**

- **Plan the transition from old to new equipment:** Planning is first and foremost in a successful transition. Compose a detailed transition plan and retain the old system until the users feel comfortable with the new system. If there are not enough internal resources to plan and manage such a transition, an outside consultant should be hired to facilitate the process.

- **Train the users in the operation of the new system:** The users must be trained to use new equipment and services. Therefore, it is important to revise training processes and to develop checkpoints to determine how well users are listening and learning. The best trainers tend to be managers who have a stake in the operation of the system.

## Vendors and Contractors

- **Vendor dedication:** Generally, finding a dedicated vendor is a key success factor in the customer/vendor relationship. Good vendors will provide quality assurance and the desire to work side-by-side with the customer's team to develop the system and solve unforeseen problems.

- **Require the vendor to verify system operation and ask the vendor many questions:** Communicate with your vendor and make sure that the systems are operational. Ask questions to clarify any uncertainties and persist until issues are addressed.

- **Hold the vendor accountable for system reliability:** Vendors should be required to put their commitment for system reliability in writing. Most presenters and panelists suggested provisions that tie the contract to a certain amount of service time before the completion of each milestone is agreed and paid.

- **Ensure contract soundness:** Before implementation begins, it is important to have a sound contract in place. The contract needs to be quantifiable, detailed, and provide sufficient accountability. A typical contract should have a clear scope of work, payment schedule, warranty, performance specifications, and a payment holdback scheme. A typical holdback payment agreement provides 70 percent upon delivery, 20 percent upon installation, and 10 percent upon total overall satisfaction.

- **Establishment of measurable specifications in the contract**: When creating a design plan, it is important to establish measurable specifications in the contract. If there is ever a deviation from the contract, the customer can refer to and depend on the contract as a guarantee that all deviations and discrepancies will be resolved. When it comes time to integrate and build the system, customers should ensure that all tasks are measurable and agreed to by the vendor and the customer.

- **Relationship to vendor**: The relationship between the customer and the vendor can be described as a marriage of sorts. Approach the relationship as a strong business partnership that will endure.

## Pitfalls in Implementation

- **Public Awareness:** It is important to educate the public about the need for and use of public safety radio communications systems. Educating the public about the system will not only garner support for the system but will also allow the public to feel that the government is not trying to "slip something past them."

- **Zoning and Regulation:** This issue appears to be the most common challenge faced by public safety system implementers. Dealing with these matters can be very time consuming and can delay implementation, but implementers should make a concerted effort to keep a cool head and jump through the necessary hoops. Often this requires attending a number of hearings regarding tower site zoning.

- **Local-User Perception:** The perception of the local user can either act as an inhibitor or serve as a catalyst for system implementation. The panel stressed the need to talk to the local users and educate them about the system. Educating the local user can help system implementers manage user perceptions of the system's capabilities and can transform the users into the system's biggest advocates.

- **System Must Work:** It is acknowledged that most projects will fall behind schedule or run over budget. However, if the system does not accomplish what it was designed to do, then there is no forgiveness. Therefore, make sure that the system does what it was set out to do.

**Vendor and Construction Issues**

- **Vendor contracts:** Public safety officials who have implemented systems suggest writing out, as much as possible, the exact role that the vendor will play in implementation. This includes writing a retaining fee into the contract. For example, the State of Michigan retains 10 percent of the cost of the system until the entire system is built and operational. This gives the state or region some leverage with which to negotiate with the vendor to insure that the system works properly.

- **Hidden costs:** What many system managers typically do not know or understand is that there can be substantial hidden costs associated with system implementation. Accessories for subscriber equipment can be costly (i.e., batteries, carrying cases) and, if system modernization includes dispatch centers, there are the costs of furniture and of fixtures. The training of users can also be a cost that many people forget to take into account.

surveys of more than 2,000 law enforcement and fire/EMS agencies found that limitations in funding is the biggest obstacle to achieving interoperability.

**Costs Involved with Land Mobile Radio (LMR) Systems**

Various cost groups represent the funding necessary for developing shared systems:

- The funding requirements of expansive systems (e.g., highly user-inclusive statewide systems, multi-county systems among populous counties, systems that provide mobile and portable roaming on a wide-area basis) are typically $120-$200 million (exclusive of end-user equipment costs and of maintenance and operations costs going forward).

- More ambitious large-scale efforts, which include full portable and mobile coverage, end-user equipment, and additional infrastructure such as new towers, can require as much as $400-$500 million.

- Small and mid-sized efforts still require tens of millions of dollars of initial capital, at a minimum (notwithstanding annual recurring costs for operations, maintenance, and equipment replacement).

- The funding requirements for shared systems can be quite large (e.g., as much as $200-$400 million in capital expenditures). The cost of system consolidation, development, and upkeep over long time horizons (e.g., 10 years) can be as much as $1-3 billion. Management and advisory committees are often key to ensuring funding and seeing to the effective expenditure of money as projects proceed.

**Common Obstacles to Obtaining Funding**

In addition to the large amount of money needed to for an upgrade, several other factors can affect the amount of funding an agency receives for its communications system. The following items were noted as key obstacles to obtaining funding:

- **Rising above the "noise:"** There are many interests competing for government funding (e.g., road construction), and if the communications system appears to be working correctly (or adequately), it is difficult to gain support for its upgrade.

- **Time:** It can take up to six-to-ten years to garner enough support and make the

jurisdiction is fortunate enough not to have a disaster, it can be difficult to raise awareness about communications issues.

- **Poor Planning:** It is very important to plan a large communications system development. It can be very difficult to obtain funding without a detailed plan that clearly defines the purpose, results, and measurable impacts the system will have on an agency's mission. Further, it is extremely important for the plan to include realistic cost assessments that are spread out over the project's life. Unsuccessful funding proposals often present costs as a single, aggregate estimate, an approach that is likely to be unpalatable to senior decision makers.

**Working with Vendors**

The amounts of funding required to build and maintain radio infrastructure throughout the country suggests that the public safety LMR market is large. However, there is a general sense that public safety LMR needs represent a small fraction of business for vendors (e.g., less than 10 percent). At the state level, there is a growing sense that public safety might be able to gain favorable pricing with manufacturers. The PSWN Program conducted a study to estimate the replacement value of public safety LMR equipment (subscriber units and owned infrastructure) nationwide as a gauge of the size of the LMR market itself. The study reflects the costs of a one-for-one replacement of this equipment with today's digital trunked LMR equipment. The results of the study estimate the value to be $18.3 billion, inclusive of the LMR equipment owned by public safety agencies at all levels of government. The $18.3 billion includes $15.4 billion in local LMR equipment, $1.7 billion in state LMR equipment, and $1.2 billion in federal LMR equipment. This estimate represents the current-day replacement value of public safety LMR equipment and does not include lease costs or operating and maintenance expenses. It also does not account for the additional costs associated with system architecture changes that would help achieve interoperability, spectrum efficiency, or system security.

**PSWN Funding Mechanism Report**

Recognizing that funding is of major concern for radio managers and politicians alike, the PSWN Program initiated a set of studies to identify funding sources and strategies. The PSWN Program-sponsored Funding Mechanisms Report for Public Safety Radio Communications provides a snapshot of funding sources available for public safety radio communications systems. The study tracks funding sources from government channels to the public safety community. The study also examines existing innovative partnerships between government and private entities

A second funding study, the Report on Funding Strategies for Public Safety Radio Communications, serves as a guide for developing funding strategies to replace or upgrade public safety radio communications systems. The study highlights the importance of developing funding strategies that consider the cost of a public safety communications system over its complete life cycle.

**Funding Sources**

Due to the magnitude of the funding requirements, most initiatives require a large infusion of funds directly from the sponsoring government agencies. In cases where large commitments of money have been made, the system developers have or will receive a significant direct appropriation from a state's general revenue fund or from a capital investment fund, for example, or have or will be the direct beneficiary of targeted, multi-million dollar capital investment bonds or their equivalents. Often, a precursor to success in receiving this level of funding was to achieve smaller funding successes, where the system developers received sums of $200,000 to $1 million to perform feasibility studies, to test concepts on a limited basis, or to execute other "pilot" projects. Sometimes these start-up funds were secured directly from government budgets. In other cases, external grants from the federal government, for example, were used or funds cobbled together by participating agencies from their general operations accounts were applied.

Actions of state legislatures are noted as the most common source for additional funding, including bond issuance and establishing user fee surcharges. Some local entities also have bonding authority and the ability to impose user fees. Additional sources of funding include partnering with private companies and imposing 911 fees. Each of these is discussed in further detail below.

- **State Bonds:** The State of Michigan funded its system by issuing a state bond. In addition to this bond, general fund money, which is employed for the communications needs of the Michigan State Police, was utilized. The tax-exempt bond allowed the state to provide the initial funding needed for system build-out, with subscriber fees used to recover some of the cost from participating agencies over time.

- **Local Bonds**: The City of Mesa is funding three-quarters of its system with bond financing. Equipment with a life expectancy below that of the bond (i.e., mobile and portable radio equipment) must be funded through other mechanisms. Bonds allow a jurisdiction to make a large expenditure up front for the system, and pay it off over the

local level include monthly surcharges on telephone lines or a percent of gross payments from telecommunications companies. Either of these can be earmarked for public safety systems upgrades.

- **Partnering with Private Companies:** Costs for building tower sites can be in part defrayed through partnering arrangements with private entities, such as power companies. This option includes leasing tower space to private personal communications service (PCS) providers. An example is the State of Delaware's partnership with a private company that leased space on a state-owned tower for PCS use. The revenue generated through this arrangement supports system operation and maintenance. Another example of this option is the State of Florida, which issued a RFP to hire a private company to manage the state's tower sites. These site managers are responsible for marketing the site and obtaining the appropriate permits. In return, the state will retain a certain percentage of the revenue. Although partnering with private companies is a viable option, some states are prohibited from doing so. For example, the bond that the State of Michigan issued to fund its system is a tax-exempt bond. As such, the infrastructure being financed by the bond can have only a 5 percent non-governmental use. This source of funding prohibits the state from leasing space on its tower to generate additional revenue.

- **911 Fee:** Fairfax County, Virginia is funding a new 800 MHz trunked system with a $1.75-per-month 911 fee on local phone bills. The Commonwealth of Virginia's Attorney General has interpreted 911 legislation to read that the money raised from 911 fees can be allocated to anyone in the 911 service delivery process.

To obtain funding, public safety agencies can also turn to the following resources:

- **Bureau of Justice Assistance:** The Bureau of Justice Assistance (BJA) supports innovative programs that strengthen the Nation's criminal justice system by assisting state and local governments in combating violent crime and drug abuse. More specifically, BJA provides funding, in the form of grants and technical assistance, to agencies seeking funding for law enforcement projects. Agencies interested in receiving assistance on grant proposals can visit http://www.search.org for more information.

The following actions were identified as best practices for securing funding.

- Regarding major statewide initiatives, including new system development as well as system upgrades and maintenance, it is important to show that costs are kept at a minimum and to follow the appropriate restrictions on how state assets and revenues are used.

- Present clear, concise arguments to constituents, showing them how shared systems will be more cost effective than stand-alone systems over time.

- Take a business perspective, approach the shared systems project as a joint capital investment, and demonstrate how the costs can be spread over multiple years. Understand and explain how the benefits outweigh the costs, and have data on all options available.

- Market the project, particularly to politicians controlling the purse strings, by drawing out the program benefits and selling the project (e.g. show the system's close affiliations with popular public safety functions). It is important to illustrate system value in tangible terms and garner state official's ownership stake in the system.

- Market to the chief decision-makers of public safety organizations (e.g., Chiefs, Sheriffs) because often times the communications systems are invisible to them and all they see is large and on-going operations and maintenance costs.

- Formalize development objectives and schedules as elements of strategic planning documents. Come to the decision-makers with a plan, not just a concept.

- Take both high-level political and grassroots approaches.

- Ensure direct contact with state and/or local officials, either one-on-one or in small groups.

- Have a "story."

- Identify as many sources of funding as possible.

- Find a political champion for your cause (e.g., the governor or a member of the state

- Tell the truth from the beginning regarding project costs and requirements to avoid the impression of future "scope creep" and maintain credibility with elected officials.

- Use consultants to ensure cost methodology and projections are reasonable. Using a consultant may also increase credibility.

- Start as soon as possible to build a favorable constituency (e.g., voters, media).

- Take advantage of press, both good and bad, to communicate issues to politicians and the public.

- Be creative in identifying sources of funding. Do not eliminate or disqualify any potential opportunities early in the process.

- Be persistent – securing funding may take multiple attempts and entail a variety of different funding strategies.

- Know the legislative and budgetary process and be aware of obstacles or hurdles you may encounter.

- Use electronic mediums (e.g., web sites, e-mail) to provide information for busy legislatures to review at their convenience.

- Tie the goals and efficiencies of the new systems to the important goals of legislative members.

- Understand your competition for the money.

- Minimize concerns about the divisions between agencies and missions; bring on as many users as possible (e.g., public works, school districts) to reduce costs. It is important to make the system so affordable that most agencies will not be able to turn it down.

**Creative Solutions to Funding Problems**

In instances where large sums were not forthcoming but where initiatives were pushed

airtime or the number of end-user units in use by a given agency. These data are converted to percentages that determine a user's cost for maintenance and operations of that site.

- In other instances, **a leased-service approach** is adopted thereby eliminating the need for large infrastructure investment. Service lease costs, along with standard end-user equipment buys, generally remain within the available operating budgets and resources of the participating agencies. Leases are sometimes more politically acceptable than bonds as they do not require approval from the voters.

- Under most formulations, **agencies remain responsible for their end-user equipment**. However, the system maintenance and operations costs are shared among participating agencies in a manner that is proportionate to a given agency's use of the infrastructure. The cost-sharing scheme is typically among the issues addressed in the agency's participation agreement. As with their end-user equipment, agencies usually fund their share of maintenance and operations costs from their operating accounts.

- Revenue can be generated by leasing tower space on government property for use by wireless service providers. This can result in a "cost avoidance" of up to $200,000. However, unless such a scheme is designed appropriately, public safety agencies may not benefit. For instance, the revenue may be deposited into a state or county general account and may be used for other purposes. In some instances where public safety shared its towers with commercial services, it was not generating enough profit to cover costs. In other instances, statutes prohibit public safety or other government entities from being in competition with private industry (e.g., companies that build and provide towers). In some cases, however, there are movements to create statutes that would allow public/private partnerships.

**Funding LMR Systems as Information Technology (IT) Projects**

The issue of funding radio systems as IT projects yielded two points of view:

- **IT review boards may be more receptive to future upgrades and requisite funding:** IT review boards, based on the expertise of those who comprise these boards, may better understand the need for software revision updates, upgrades of equipment, and certain risk migration strategies. The ability to tap this knowledge

**Marketing Public Safety Radio Communications to Funding Bodies**

The critical issues surrounding public safety radio communications must be more effectively marketed to governments and citizens. Unlike the general awareness that accompanies requests for increased funding for education and highways, funding for public safety radio communications is largely misunderstood by governing bodies and the public at large. Legislators and budget officers need to understand the need for additional funding to procure and maintain radio communications systems, as well as the evolving nature of radio communications technology. Likewise, communities need to understand how radio communications directly affect their safety.

- **Elevate the importance of public safety radio communications:** The public safety community needs to elevate the critical need for radio communications infrastructure and the funding needed to modernize and maintain these systems. Public safety and public safety systems need to be placed at the same priority level as an effective highway system and a ready national defense. Certain education efforts can be employed to help policymakers understand LMR technology and the impact the lack of funding has on public safety's operational readiness and capabilities.

- **Promote LMR systems in layperson's terms:** Public safety radio communications and related funding requirements need to be communicated to local, state, and federal governing bodies in order to justify requisite funding. However, the highly technical issues must be made understandable to policymakers. "Layperson's guides" written by non-technical personnel are one means for explaining the issues in non-threatening and easy-to-understand terms. The text should avoid technical jargon and should employ inclusive terminology and empirical data to help streamline the message to legislative and budgetary bodies. Explanations to political representatives need to be clear and succinct.

- **Develop a well-defined goal statement:** Budget officers and government decision makers are more apt to understand the need for a system in relationship to a well-defined goal. Examples of compelling goals include meeting federal government or FCC requirements, enhancing personnel safety or operational capabilities, improving efficiency and saving taxpayer dollars.

- **Promote LMR systems using direct stakeholders:** Utilize the users to "sell" the

- **Build relationships with the community:** Communicate to citizens the compelling need for a societal commitment to public safety communications infrastructure and the possibilities of what could happen without much needed funding. Targeted education to specific citizen groups (e.g., citizen advisory committees) may be necessary to get a specific project into a bond election or to overcome resistance to new taxes or user fees.

**Common Funding Mechanisms**

Many public safety agencies employ similar funding mechanisms and tap into similar revenue sources to fund radio communications needs. The most common revenue sources and funding mechanisms include:

- **Surcharges:** State and local governments impose surcharges on services. Surcharges for public safety are typically imposed on automobile and boat licenses, and on telephone services. Although surcharges are a common means of generating revenue, many panelists noted that they do not generate enough financial resources to support the full life cycle of a public safety radio communications system.

- **Specialized Funds:** State and local governments often create special funds that hold revenues for a targeted purpose, such as 911 call centers and public safety in general. These funds are financed through tax revenue, surcharges, and intergovernmental transfers. Often unused money can be returned to the fund for later use.

- **Directed Taxes:** Taxes, such as income or sales, are sometimes earmarked for public safety radio communications.

- **Grants:** The federal government has money available to public safety agencies in the form of grants. Most of these grants are for operational purposes, however, some are for infrastructure improvement. Generally this money is not enough to support the full life cycle of a radio system, but may be enough to help with system planning.

- **Private Foundations:** Some private foundations have been known to give money for communications systems and infrastructure upgrades at local levels of government. For example, Intel (a chip manufacturer) helped fund an information-sharing system for a county near Portland, Oregon.

Approaches to management and coordination of shared systems vary. In some cases, they are highly structured and formal (e.g., cooperative agreements, stratified levels of participation, well structured priority schemes). In other cases, the combined operation of a shared system hinges on a simpler device, such as turning each shared site into a cost center. Generally, ownership issues are being resolved through the careful design and implementation of joint ownership and management schemes.

**Basic Principles of Project Management and Coordination**

It is generally agreed in the public safety community that managing and coordinating a shared system is a daunting task. The following paragraphs detail a number of suggestions regarding this issue.

- **Determine Management Structure:** In some instances, high-level state planning documents address management and coordination issues. In other cases, management and coordination is vested in the majority partner, although the minority partners retain some concern for addressing their unique needs. Mechanisms such as communications resource management boards and professional mediators can be used to assist in decision making and exception managing. Management should have command and control authority for the system to allow for centralized decision making on system issues such as software management and prioritization of access.

- **Build Consensus:** Effective management and coordination depends on developing and proceeding from a high degree of consensus on project goals. Consensus needs to be reached among participating law enforcement, fire, EMS, and public service organizations and formalized through some written agreement, such as an MOU. Finding common ground on the core issue of service delivery generally helps foster consensus.

- **Pool Resources:** Agreements often require all users with frequencies to pool their resources. Those agencies without frequencies usually pay a fee. The agreements also typically establish levels of customers and partners, with priority going to public safety talk groups, and call for system directors elected by the system users.

- **Standard Operating Procedure:** It is agreed that a written standard operating procedure is needed. This procedure offers the system some sort of framework within which to operate.

system manager needs to remember that trying to please everyone leads to pleasing no one.

- **Use Time Wisely:** The level of control a system manager has is directly proportional to the amount of time invested in system control.

**Best Practices for System Management and Coordination**

A number of best practices for managing and coordinating a shared system were generally agreed. These points include:

- **Establishing system capabilities upfront:** It is important to establish the extent of system capabilities with partnering agencies before a partnership agreement is formed and finalized. A "no surprises" approach to enumerating the functionality of the system and to establishing the ground rules for joint system use and operation is essential.

- **Managing provision of features:** As a basic rule, radio equipment should be kept as simple as possible to address the mission requirements of users. It is important for system managers to make a detailed assessment of how the system works and then determine what features will be provided while meeting users' needs. Features such as telephone interconnect and private call can have a nontrivial impact on channel usage and system performance. Once features are provided, priority access schemes need to be identified and the use of features needs to be monitored on an ongoing basis.

- **Conducting pilots of various technology solutions:** Pilots provide a realistic demonstration of a technology's capabilities and allow agencies to learn about the benefits in their own environment. It is important for users to experience the technology firsthand. Pilots also provide a means to maximize competition and gain knowledge that precludes vendors from over-promising technical solutions while under-promising resource costs.

- **Maintaining the ability to change your plan:** Staying flexible increases the likelihood of satisfying management and coordination concerns of stakeholders. Designing and implementing partnership agreements almost always is a "bumpy" process. Management flexibility facilitates this process, as do contracts that can be modified to accommodate necessary changes.

- **Establishing common mechanisms for coordination:** Formalized agreements, stratified levels of participation, and well-structured priority schemes were discussed as mechanisms for coordination. The following are key points:

  - It is important to negotiate solid vendor contracts as a controlling mechanism. These agreements should contain clear scope-of-work stipulations, payment schedules, warranty provisions, and measurable performance specifications.

  - It is equally important to survey users, to define talk groups that address user operations, and to specify a standardized priority scheme for emergency situations.

  - It is important to document agreements and standard operating procedures regarding all aspects of system management (e.g., users, coverage, features, priorities, maintenance, security) and have each agency sign these documents to prevent any misunderstandings as to what was agreed upon.

  - It is important to have various committees or teams providing input and designing policies and procedures for system management and coordination. It is important that decision-makers make up these intergovernmental committees. However, there is a danger in having too many participants trying to manage a complex system.

- **Assembling a solid, well-staffed organization:** Employ individuals with technical expertise and use these individuals to perform several levels of review. Such an investment will save money and prevent rework.

- **Supporting and managing the expectations of the user community:** Before establishing a system, talk to the users to ensure their requirements are met. Efforts should be made to address actual day-to-day user requirements before less routine needs are accommodated. It is important to communicate with users to determine a realistic range of functionality that meets operational requirements, as certain add-on features could increase maintenance costs significantly. System managers should consider using a consultant to provide technical and engineering support to help the users define their needs.

- **Using third parties as appropriate:** The use of consultants and integration contractors can help organizations better understand how to manage their systems and

goals of the system to prevent a loss of focus and direction. It is important to continuously communicate the project goals and risks to the users, old and new alike, and to update operational processes and procedures to balance specific user needs with system considerations.

## SPECTRUM, COVERAGE, AND OTHER KEY DESIGN ISSUES

Another gating issue for shared system development is the availability of a sufficient amount of spectrum that is configured in a manner that affords enough flexibility for the intended applications.

Most system developers are implementing 800 MHz systems because spectrum is still available at 800 MHz. However, not all shared systems being implemented are 800 MHz systems. VHF systems are being put in place as well, although systems developers involved with VHF efforts can face a significant challenge in acquiring sufficient amounts of spectrum.

Reports of coverage and performance problems at 800 MHz have persisted. To better understand these problems, some system developers performed tests prior to their commitment to an 800 MHz system. Antenna placement and site location appear to be critical design parameters for 800 MHz systems, more so than for VHF and other lower band systems. In addition to testing, system developers are hedging against 800 MHz coverage problems by including very detailed coverage requirements in their RFPs (e.g., link performance parameters for specific buildings and specific floors within specific buildings). While this is one means of addressing potential coverage problems, it may cause vendors to overdesign the systems and drive systems costs to very high levels.

Whether operating at VHF, 800 MHz, or in some other band, the general technical characteristics of shared systems in place or under development are that they are digital (sometimes mixed mode, i.e., analog/digital), narrowband, trunked, and configured for some degree of simulcasting. In addition, network management akin to that done on computer networks and other automated information systems is more prevalent among current generation radio communications systems. Data and voice are often accommodated over one common infrastructure (however, the commercial service Cellular Digital Packet Data is a commonly used

provide the necessary coverage. Some agencies have compensated through remedial measures (e.g., placing repeaters in vehicles) that have become integral parts of the physical infrastructure.

**800 MHz Study**

The PSWN Program commissioned the consulting firm Booz·Allen & Hamilton to perform an independent evaluation of the relative merits of 800 MHz as an operating frequency for public safety. The report documenting the findings of this study was distributed to symposium attendees for their review and comment. The report was discussed briefly at the conclusion of the PSWN Program presentation. Key findings include:

- Some interoperability improvement has occurred with 800 MHz systems, but these improvements generally occurred when adjacent jurisdictions operated, or were also migrating to 800 MHz systems;

- Regional plans for using 800 MHz frequencies were created from templates;

- Membership in NPSPAC regional planning committees was not fully representative of all public safety users in a region (often times these committees were made up of law enforcement agencies from large metropolitan areas while smaller jurisdictions and fire departments did not participate on the committees as frequently);

- Lack of adequate funding affected participation in the regional planning process and limited the implementation of new 800 MHz systems;

- Proliferation of a variety of incompatible 800 MHz systems has limited the ability of public safety agencies to achieve nationwide interoperability; and

- Misconceptions exist concerning the propagation characteristics of 800 MHz systems.

**Other Key Design Issues**

In addition to spectrum and coverage, systems are being designed in light of design constraints and conditions that can vary significantly from development effort to development effort, as well as within a particular design effort itself. These items include:

- Varying terrain, foliage, ground cover, and climate conditions;

- Varying numbers and types of subscriber units;
- Varying intensities of different types of public safety agencies within a region; and
- Varying degrees of participation from agencies that are only occasionally considered public safety agencies.

## BORDER COORDINATION ISSUES

Public safety agencies in regions along the Nation's northern- and southernmost borders have additional issues to contemplate when developing or upgrading their shared systems. Wireless activity on the other side of the border (whether Canada or Mexico) can dramatically affect the design and performance of public safety systems. The following are a number of key considerations for agencies with systems along the border:

- **Coordination processes:** U.S. public safety agencies operating communications sites inside of Line A (within 75 miles of the U.S./Canadian border) are required to get approval from Canadian authorities before operating their system. The governmental coordination processes can be time consuming, taking upwards of two years, although information technology is easing this process.
- **Different operational parameters:** Regulations for LMR operations in both countries bordering the United States differ from those in the United States. Understanding the differences up-front helps identify potential problems in advance.
- **Cross-Border Interoperability:** Public safety agencies at the border may have to interoperate with agencies from the adjacent country. It is important to develop an understanding of the methods and procedures for achieving this interoperability.

## SITE ACQUISITION

The most common obstacle faced in the site acquisition process is opposition from local communities to the development of tower sites in "their backyard," due to aesthetic and health concerns. Another common and more recent obstacle is competition for site locations from commercial wireless service providers. Due in part to these factors, two or three years are

writing, based on substantial evidence in a written record. Radio frequency (RF) emission levels are among the criteria for evaluating site applications. The FCC has established regulations regarding these levels. If a proposed placement meets these requirements, a local government cannot deny placement based on RF emissions.

The primary role of the FCC in antenna siting is to register antenna structures and ensure compliance with the National Environmental Policy Act of 1969 (NEPA). Compliance with NEPA is critical to addressing the concerns of those who may otherwise oppose the siting. Antenna structures higher than 200 feet above ground level must be cleared with the Federal Aviation Administration (FAA) (i.e., determination of "no hazard' and registered with the FCC). NEPA requires an Environmental Assessment (EA) to be filed if the site is environmentally sensitive or if excessive RF emissions exist. Situations requiring EA documentation include:

- Officially designated wilderness areas or wildlife preserves;
- Threatened or endangered species or designated critical habitats;
- Historical or archaeological sites or Indian religious sites;
- Floodplains;
- Significant changes in surface features (e.g., wetland fill, deforestation, water diversion);
- High intensity white lights in residential neighborhoods;
- Excessive RF emissions (as defined by FCC's Office of Engineering and Technology); and
- Other situations as required by the FCC or as petitioned by an interested person.

**Best Practices Relating to Public Relations**

Effective public relations will help mitigate and dispel the myths associated with the development of a tower site. Education on the need for a tower is one of the most important actions to be taken in the site acquisition process.

- **Leverage political and executive support:** Political and executive backing at all levels of government can prevent and mitigate opposition. Relationships with local representatives are particularly beneficial. It is important that system planners thoroughly communicate the utility of the site through presentations that include panoramic pictures of the tower and the surrounding area. It is essentail to educate all potential government supporters and decision makers.

- **Educate and inform the surrounding community:** Community resistence to the construction of a tower seems to be inversely proportional to the community's understanding of the benefits of the tower. Counsels, boards of supervisors, commissions, community action groups, and local citizens need to be educated and informed of the direct relationship between the tower and the safety of the community's citizens. As the message regarding the site's utility is communicated and understood, community opposition typically decreases.

**Best Practices Relating to Pre-Site Implementation Issues**

An exhaustive review of pre-site implementation issues is a way to manage the risks associated with the site implementation process. Common best practices include:

- **Conducting risk assessments:** Risk assessments of the potential site will save time and money in the future and will guard against unexpected opposition. Investigate potential NEPA issues and keep good records to demonstrate findings in case of petitions by opposition groups. Explore possible issues for potential sites including: geotechnical (e.g., foundations, drainage), property (e.g., access roads, underground storage, power to site), and safety (e.g., flight path clearance, structural soundness of facilities, the presence of asbestos, ease of access). Research all existing local ordinances.

- **Identifying and obtaining sites:** Potential sites should be obtained before or during the early stages of contracting with a vendor. Minimize the loss of time and money by obtaining and preparing tower sites well in advance of major system milestones such as infrastructure installation and testing.

- **Considering innovative site and design solutions:** Investigate the use of innovative design solutions for towers. Some public safety agencies have employed techniques that camouflage towers in an attempt to alleviate aesthetic concerns. However, the

parties to handle. However, some public safety agencies are reluctant to depend on tower space owned and operated by non-government entities due to security issues and restoration procedures.

- **Using real estate experts:** Agencies should identify and use subject matter experts in acquiring real estate. Furthermore, agencies should hire appraisers to obtain a sense of land costs in the target area.

- **Working closely with local government planning staff:** Local planning staff have a detailed understanding of the local ordinances and regulations that can greatly affect the site acquisition process. In addition, they are aware of the political realities that exist in the local jurisdiction and have experience dealing with these issues in the political arena. Agencies should be cautious about making false assumptions about the availability of land owned by their jurisdictions.

- **Understanding the "domino" effect of tower location:** Tower locations are an important consideration in the site acquisition process. If a selected tower location becomes unavailable for any reason, the system coverage and performance could be adversely affected.

- **Performing significant up-front planning:** Agencies should plan strategically to minimize the number of tower locations needed. They also should look at various options for minimizing land use. For example, it may be more cost effective to pay for a more expensive stand-alone tower that uses minimal land area rather than purchase a less expensive guyed tower that requires significantly more property.

## FREQUENCY REGULATORY AND LICENSING ISSUES

The two organizations primarily responsible for telecommunications issues affecting local, state, and federal agencies are the FCC and NTIA. The FCC is responsible for licensing radio frequencies to non-federal public safety agencies and establishes policies and regulations governing that use. The NTIA is responsible for licensing radio frequencies for federal public safety agencies and serves as the President's principal advisor on telecommunications matters.

In June 1995, the FCC and NTIA sponsored the Public Safety Wireless Advisory Committee (PSWAC), a year-long effort targeted at developing a broad vision for the

- **Funding:** An alternative source of funding needs to be developed.

In August 1997, the FCC and the NTIA formed a Public Safety Communications Joint Working Group to address the PSWAC recommendations. Of immediate concern for the Joint Working Group is the Balanced Budget Act of 1997, which includes a provision to reallocate 24 MHz of spectrum between 746-806 MHz for public safety use. This plan for reallocating spectrum stems from the PSWAC recommendation for an additional 95 MHz. The 24 MHz of spectrum at issue is currently assigned to TV stations and has not yet been reallocated.

The FCC issued a Second Notice of Proposed Rulemaking (Second Public Safety NPRM) in response to this provision for reallocation. Through the Second Public Safety NPRM, the FCC sought input from the public safety community on how to best use the additional public safety spectrum. Highlights of the Second Public Safety NPRM follow:

- Setting a goal to solve the interoperability problem among public safety agencies;
- Proposing a significant amount of spectrum devoted specifically to interoperability;
- Proposing regional committees be given licensing responsibilities;
- Proposing voluntary Cellular Priority Access (CPA); and
- Proposing to further develop a regulatory framework that encourages competition.

The FCC emphasized that the NPRM proceedings are not restricted to the reallocation of the 24 MHz of additional spectrum. The NPRM also addresses longer-term issues surrounding public safety radio communications, such as interoperability, regional planning, and the continued use of aging radio communications equipment. The Commission's position is that the Second Public Safety NPRM is the best opportunity for public safety agencies to shape the policies that are the foundation upon which public safety agencies' radio systems are built and the FCC encouraged public safety agencies to participate fully in the rulemaking process.

On August 6, 1998, the FCC adopted a First Report and Order (First R&O) and a Third Notice of Proposed Rulemaking (Third NPRM). They were released to the public on September 29, 1998. Petitions for reconsideration to the First R&O could be filed by the public through December 2, 1998. Responses to the Third NPRM were due to the FCC by January 4, 1999.

- Spectrum is channelized into narrowband and wideband channels that will accommodate voice, data, image, high speed data, and video transmissions;

- From the 24 MHz of spectrum in the 700 MHz band, 12.6 MHz is designated for general use, 2.6 MHz for nationwide interoperability purposes among all public safety agencies, and 8.8 MHz is reserved for future designation; and

- The Third NPRM sought comments on how to perform licensing and administration of reserved spectrum.

The Third NPRM also sought comments on a variety of other issues:

- Alternative proposals for use and licensing of the 8.8 MHz;

- Plans for 2.6 MHz of interoperability spectrum;

- Designation of interoperability channels below 512 MHz;

- Use of standards to improve interoperability;

- Technical solutions to address possible interference problems to global navigation satellite systems; and

- Methods for obtaining Year 2000 compliance information.

The FCC urged public safety agencies to answer the Third NPRM, support the NCC, and closely monitor the market penetration of digital TV, which will affect the availability of this spectrum for public safety use.

The FCC also discussed its waiver process. Applicants can file waivers to standing rules for consideration by the Commission. Petitions for waivers are put on public notice for others to make comment. In evaluating waiver applications, the FCC considers a number of factors:

- How the proposed concept would enhance the safety of personnel and the public;

- How the concept would promote interoperability and increased mission coordination;

The NTIA and the FCC are concerned with public safety but both need to balance several issues. The public safety community is competing against broadcasters and wireless service providers for spectrum. The public safety community needs to develop a better understanding of the requirements and needs of commercial service providers in order to offer compelling rebuttals to rulemakings regarding spectrum issues. Understanding distinctions between commercial and private service is important as shared systems are created.

The FCC appears interested in long-term solutions to some of the current shortfalls found in its rules today. Some believe that FCC rules need to be relaxed, that the states should be allowed to administer them, and that procedures need to be more regional-based because the same rules would not work for the entire country. Others believe that rules should be administered at the federal level and that a guiding national hand was missing from the NPSPAC regional planning process. Resources need to be provided to support these planning processes. Educating key stakeholders about spectrum issues is another key matter. Senior-level individuals associated with organizations like the International Association of Chiefs of Police and the Major Cities Chiefs for the U.S. and Canada (with 55 major chiefs) need to be educated on important spectrum issues. These individuals will be key in pushing for spectrum policy changes and system funding, and they are also in position to make decisions about shared systems development.

## PUBLIC SAFETY NATIONAL COORDINATION COMMITTEE

In its First Report and Order in WT Docket 96-86, the FCC established the Public Safety NCC to oversee planning for the interoperability spectrum in the newly allocated 700 MHz band. The FCC understands the importance of coordination in this band and hopes the NCC will support interoperability standards and planning without repeating work that has already been done to address the issue of interoperability. In addition, the FCC would like the NCC to build on the PSWN Program's groundwork in this area. The NCC has several core responsibilities. The committee's responsibilities include:

- Formulating an operational plan to achieve interoperability in the 700 MHz band as well as for using interoperability spectrum in other bands.
- Recommending technical standards (digital modulation, trunking, and receiver standards) to achieve interoperability.
- Formulating recommendations on federal access to the 700 MHz band.

committee membership includes the PSWN Program. Additionally, the NCC will have at least three subcommittees: Interoperability, Technology, and Implementation.

The first meeting of the NCC was held April 29, 1999, in Washington, DC. To help ensure broad participation, subsequent meetings are being held throughout the country, most likely in conjunction with other public safety events and conferences. Meetings have been held on September 24, 1999 in Lansing, Michigan, and November 19, 1999, in New York, New York. During these meetings the NCC has made progress. The subcommittee recommendations that have been forwarded to the steering committee for consideration are summarized below:

**Technical Subcommittee Recommendations**

- Adopt Project 25 CAI standards and vocoder standards as the baseline standard for narrowband interoperability channels in the 700 MHz public safety band
- Ask for suggested standards for voice encryption and data communications on interoperability channels

**Interoperability Subcommittee Recommendations**

- Develop a priority system for "mission critical" communications
- Ensure conventional-only calling channels are implemented with coverage equal to that of all other interoperability channels
- Develop standardized nomenclature for interoperability channels in the 700 MHz band
- Establish 32 12.5 kHz channel sets classified as follows: 2 calling and 30 tactical (4 EMS, 4 fire, 4 law enforcement, 14 general public safety, 2 other public service, and 2 mobile repeater)

**Implementation Subcommittee Recommendations**

- Evaluate funding options through a funding working group
- Analyze the digital television transition

about the NCC is available on the World Wide Web at:
http://www.fcc.gov/wtb/publicsafety/ncc.html

**Federal Participation in the NCC**

The Federal Government does have a need to interoperate with state and local governments nationwide. The Federal Government also realizes that efficiencies, in terms of spectrum, money, and number of sites, can be achieved by developing shared systems. The Federal Government sees the NCC as a catalyst towards shared systems development and therefore seeks to participate in its activities. As stated above, several federal departments and agencies are serving as cosponsors.

The Federal Government also believes that if true interoperability is going to exist, it must include federal public safety users. Federal agencies are not looking to license spectrum in the state and local 700 MHz band, but instead are seeking coequal access to the spectrum for shared, joint-use, or interoperable systems. The NCC will provide a forum for federal, state, and local sharing issues and methods of interoperability can, and will be developed by the committee.

**FCC Views on the NCC**

The FCC has dual concerns regarding the 700 MHz band. It is not only concerned with public safety's planning and management of the band, but also with the digital television migration that is helping to free the band for public safety. The FCC also would like to formally establish a process for improving interoperability in bands below 512 MHz. They would like to designate a number of channels in each band below 512 MHz for national calling. The FCC believes the NCC is the proper body to address these issues, and the FCC has the rulemaking authority to act on the NCC's recommendations. The FCC also believes that operational procedures need to be included in any plan developed by the NCC.

## REGIONAL PLANNING

Regional planning has been performed for the NPSPAC 800 MHz public safety channels. Generally, this regional planning has led to effective use of these channels. There are some notable limitations, however. For instance, federal agencies have no direct access and limited secondary access to 800 MHz channels, which can be a barrier to establishing interoperable wireless networks. Also, geography plays an important factor in a decision to use 800 MHz, as

- It established some operational guidelines for certain channels (i.e., mutual aid channels); and

- The NPSPAC process could be used in the allocation of the 746-806 MHz spectrum by using the existing committees and the expertise obtained.

Some of the negative aspects include:

- The process lacked sufficient oversight or guidance in developing Regional Plans. The NPSPAC Final Report recommended a review committee to help mediate interregional problems, however no such committee was instituted;

- No common database was established to identify what the channels were being used for or who was using them; and

- The NPSPAC plan did not allow for ways to interoperate with anyone using the general pool frequencies.

## EDUCATION AND AWARENESS

In addition to providing a forum for sharing information, the symposiums provide current information to educate and raise awareness about topics of special interest in the public safety community.

### Tutorials

In response to suggestions from symposium attendees, the PSWN Program offers tutorials in conjunction with symposiums. The tutorials were designed to educate and inform the public safety community about topics of interest. The following tutorials have thus far been offered by the PSWN Program:

- **System Planning A-Z:** This tutorial provided an introductory overview to the major elements of devising major wireless network projects. The tutorial covered all aspects of life cycle planning and system development, including helpful strategies to better design, manage, and implement major radio system projects. This tutorial also provided a discussion of common pitfalls associated with system planning and

trunked systems. In addition, the tutorial also included a discussion on an example operational 800 MHz trunked system operated by the Council of Governments in the Washington, D.C. metropolitan area.

- **Understanding Frequency Refarming:** This tutorial provided a review of the frequency coordination process using the TSB-88 methodology (this is a TIA standards effort, which resulted from the TIA TR-8 Work Group 8.8 final report). TSB-88 provides the methods and procedures for conducting the co-channel and adjacent channel interference analyses that must be considered when coordinating channel assignments for frequency refarming. Spectrum refarming results in a more detailed and complex frequency coordination process to accommodate the fielding of bandwidth efficient narrowband technologies. Discussions focused on the additional information now required for efficient frequency coordination, including differing channel widths, types of modulation, and channel performance requirements. In addition, co-channel and adjacent channel interference considerations were outlined. After descriptions of the modeling and acceptance testing procedures were provided, a variety of scenarios were presented of the types of evaluations performed under the TSB-88 methodology.

- **Writing Grant Proposals:** This tutorial provided an overview of grant programs that may support public safety activities. More specifically, the tutorial focused on the Telecommunications and Information Infrastructure Assistance Program (TIIAP) supported by the NTIA. The discussion included a presentation from the Parker, CO Fire District, which successfully received TIIAP funding for a distance learning project. The tutorial also covered the broad issues that should be included in a successful grant proposal. These issues consist of what to include in the detailed background information (e.g., the technology concept, nature of the project and how it will be conducted, the project timetable, and desired outcomes). The tutorial also described how the proposal should include facts and statistics that show the "national significance" of the technology project. The proposal should also show how the project is forward looking and can be seen as a model for other agencies to emulate.

**Site Visits**

Site visits are another way the PSWN Program helps share knowledge and best practices with public safety agencies. The visits allow local or state agencies to showcase a variety of technologies employed by their jurisdiction and can give ideas to other agencies interested in

offered an overview of the operations of the backup network control center. The visit included a tour of a Department of Corrections prisoner transport bus, a police motorcycle, and the department's mobile command vehicle. Two ALERT vehicles were also showcased at the visit.

- **Orange County, Florida Radio System Prime Site:** The Orange County Sheriff's office and the City of Orlando provided a tour of the county's prime radio site and Emergency Communications Center. The Orange County system is co-owned and operated by the City of Orlando, Orange County, and eight surrounding jurisdictions. The Emergency Communications Center has recently been upgraded with $4 million of new equipment. The Orange County system is based on a Motorola Smartzone infrastructure.

- **U.S. Customs National Law Enforcement Communications Center (Orlando, Florida):** The U.S. Customs provided a tour of its hub for LMR and long-range wireless networks. The center is also a hub for engineering new approaches to shared LMR systems. It is the Federal Government's largest national communications center with 24-hour-a-day service. The tour included a briefing on the center's formation, its capabilities, and its pilot testing efforts. The tour also included a brief demonstration of the wireless technologies used at the facility.

**Security Briefing**

There are emerging security issues associated with evolving public safety radio communications systems. These issues include the need for security from an infrastructure protection perspective, the cause of new security threats and vulnerabilities, and the security challenges that face the public safety community.

Currently, evolving public safety digital land mobile radio (DLMR) systems are envisioned as operating as large automated information systems (AIS) with open interfaces providing digital-based interconnectivity with other systems and subsystems. While the latest DLMR technology will increase the efficiency and effectiveness of public safety communications, a host of security risks could be introduced unless effective mitigating actions are undertaken based on security awareness and understanding. Most importantly, digital radio systems must be configured and managed in a way that will provide adequate protection from computer-based threats.

Four security-related issues are at the core of creating effective security procedures for

- Understanding the tools and techniques available to protect these systems.

The PSWN Program has assessed multiple communications centers around the country to further understand the security issues associated with evolving public safety communications systems. The findings from these assessments show several potential problems. These problems include: the transmission of sensitive information over clear channels, a lack of protection of computer and data systems from outside intrusion, and weaknesses in the physical security of the systems.

The PSWN Program has developed a variety of products and recommendations that the public safety community can use to address these problems. The ***Public Safety Communications Security Awareness Guide*** explains public safety issues in clear terms and highlights actions that leaders can take to address security problems. The ***DLMR System Security Guidelines Recommendations Report*** provides a set of recommended guidelines to improve administrative, physical, computer, and communications security for DLMR systems. The PSWN Program also encourages the public safety community to take a life cycle approach to systems security. Accordingly, it has developed two guides, the ***LMR System Recommended Security Policy*** and the ***LMR System Security Planning Template*** to help agencies develop and implement security policies.

The federal government has also recognized the importance of emergency services as a critical infrastructure and has taken several actions to raise security awareness on a national level. In 1998, the President issued several a Presidential Decision Directive (PDD) that addressed the government's plan to coordinate the public and the private sector to address security vulnerabilities (PDD 66). The President also issued a subsequent directive (PDD 67) that addressed the continuity of government operations.

**Maintaining Awareness on Spectrum Issues**

Spectrum issues have been discussed at length with the public safety community and have provided a greater understanding of the complexities of the issue. Topics have included:

**The Second NPRM for Public Safety Before the FCC (WP Docket 96-86):** The FCC provided an explanation of how the current allocation proceeding of 24 MHz of spectrum for public safety use is being approached. Keys to this approach are:

- Meeting the demonstrated and expressed needs of the state and local public safety user

- Shortening the waiting time for access to this spectrum;

- Encouraging the implementation of advanced technologies while minimizing costs to users;

- Delegating authority to the appropriate regional or national body; and

- Selecting simple regulatory solutions.

**Public Safety and Radio Spectrum Guide:** The Public Safety Radio Spectrum Guide was developed to draw attention to the remaining spectrum needs of public safety (73.5 MHz, as identified by the Public Safety Wireless Advisory Committee). Specifically, the PSWN Program has positioned the guide to educate public officials about, and foster support for, the various issues surrounding public safety radio spectrum. These issues include:

- The scarcity of spectrum;

- The distribution of public safety agencies within spectrum bands; and

- The lack of a firm transition plan for reallocated spectrum

The guide was developed in partnership with the Associate Attorney General's office and the National League of Cities (NLC). It has been distributed to Congress, the National Fire Caucus and through NLC stakeholders. For additional information on spectrum and other topics related to public safety communications, the PSWN Program web site can be found at www.pswn.gov.

**Public Safety and Wireless Communications Interoperability Guide:** This guide was developed to define public safety interoperability and explains the key issues causing interoperability problems in clear, concise terms. Specifically, the guide educates public officials about the following issues underlying interoperability shortfalls:

- Spectrum limitations;
- Funding limitations;

## LOCAL PERSPECTIVES ON SHARED SYSTEM DEVELOPMENT

Shared wireless communications systems are becoming increasingly prevalent, and fiscally necessary, at local levels of government. Goffstown, New Hampshire, Douglas, Arapahoe, and Jefferson Counties in Colorado, Orange County Florida, and Fairfax County, Virginia are among the jurisdictions that have developed or are in the process of developing multi-jurisdictional, multi-discipline public safety communications systems. These areas face unique challenges in funding and coordination in implementing their systems. They also have some successes to report. Some of the successful practices include:

- **Community Interaction:** It is critical to sell the project to the local community. The community will in turn sell it to local government officials. It is also important to sell the idea of a town-wide or county-wide system to the community because members of the community will see the value and reduced cost of the project.

- **Securing Property and Permits:** Often times, local agencies have an advantage when securing tower sites because they can partner with other local government entities to share land or facilities. Agencies should look for other government entities such as schools and government-owned buildings as potential sites for towers.

- **Contract Management:** Local agencies should include several key elements in the contract to develop their communications system. The contract should include specific testing requirements that must be met before the system is accepted and a warranty that starts after the system is accepted. Local agencies should also think seriously about adding training to the contract because it is a facet that is left out of many contracts.

- **Reducing Costs:** Many local agencies are able to reduce system costs by acting as their own general contractor and performing their own project management. Other agencies were able to reduce costs by leasing their spare tower space to other entities.

- **System Documentation:** Agencies should keep records of everything including the dates and names involved in all key transactions. This is critical because often times a systems development occurs over several years and the key players and managers change.

- **Training:** Provide detailed training on the new system to ensure users are comfortable

among the systems. Additionally, it has simplified the process of adding mutual aid channels to the radios.

- **Planning With Surrounding Region:** It is important to involve the surrounding region when planning major system developments. This planning can mean establishing a region-wide mutual aid plan and operational procedures for conducting interoperable operations. It can also include investigating group procurements for all the jurisdictions that buy from the same vendor.

## STATE PERSPECTIVES ON SHARED SYSTEM DEVELOPMENT

Shared wireless communications systems are becoming increasingly prevalent at the state level. Michigan, North Carolina, Pennsylvania, Colorado, Florida, Montana, Nevada, South Carolina, Texas, Utah, Wisconsin, and Hawaii are among the jurisdictions that have developed or are in the process of developing multi-jurisdictional, multi-discipline public safety communications systems. The large-scale nature of these statewide efforts, inclusive of wide area portable or mobile coverage, new infrastructure, numerous tower sites, and a variety of end-user equipment, present unique challenges for shared systems development.

- **Program Initiation:** Successful development and implementation of a statewide shared system requires a tremendous amount of political support, either from the governor, state legislature, or both. It takes a compelling vision, coupled with an understanding of the urgent need to improve public safety communications, to achieve the needed level of support. Furthermore, the state must be willing and able to take on integration responsibilities for the system and work to overcome turf and coordination issues with local and federal partners.

- **Project Planning and Management:** Identification of the users' true operational needs is the first step in successful project planning. The system managers must define a set of minimum user requirements that are nonnegotiable. There is also a need for widespread governmental collaboration on project strategy in the planning stages. This includes involving many state agencies and groups of interested local agencies to get their "buy-in." A specific organization and individual needs to be responsible for the core project management activities, including planning, organizing, staffing, and monitoring all aspects of development and implementation to manage risk. Hiring an outside consultant, or finding experienced "in-house" managers with expertise in

consultant is useful in both contract negotiations and for quality assurance during implementation. It is critical that expertise be available in all areas of the system development (e.g., communications, real estate, Federal Aviation Administration regulations, FCC licensing, zoning, tower siting).

- **Project Costing and Fiscal Management:** With projects of this magnitude, costs need to be tightly monitored and controlled. A cost baseline should be established with the contract. All costs incurred during the design and implementation need to be compared with the contract, and the state needs to establish and maintain control over the costs. Cost allocation schemes and billing for local agency participation can become burdensome quickly so simple procedures and tight internal controls are important.

- **Operations and User Support:** User support for the system is important for it to be successful. The operational questions of users must be answered quickly and clearly, training must be provided so that equipment is used properly, and mechanisms are in place for feedback and problem resolution. User groups need to be kept informed and involved in selecting the proper equipment, testing coverage and other system features, and suggesting future enhancements. Additionally, users should focus on addressing their joint requirements. This emphasis helps minimize infighting and non-technical barriers (e.g., political and turf issues).

- **System Governance and Ownership:** Successful statewide shared systems often share governance responsibilities among participants. Generally, shared systems have an executive council, or a similar group, that comprises representatives from each of the system participants. This makeup ensures equal representation on matters related to the system and provides a forum for coordination. It can be a good practice to rotate the leadership of the council among the various members. Additionally, efforts have been successful when each participant owns part of the system. This way, the system is analogous to a chain. Each participant owns a link, but needs each of the other participants to make the system work.

- **Site Maintenance.** In any large state development it is critical to have efficient maintenance systems. Modern software can perform inventory tracking, as well as analysis functions that can list common failures, recommend timely service, and reduce diagnosis times for technicians. Efficient maintenance software can also provide information to help managers make decisions. For instance, the software can analyze

plan for, interoperability and should also train users on the interoperability plan. The plan could include how the state will resolve border communications issues, how to interoperate during emergencies such as wildfires or natural disasters, and how to integrate personal radios (e.g., during search and rescue operations) with public safety communications systems. The interoperability plan could also have an appendix of all of the communications resources available and their location throughout the state. The interoperability plan should be tested through a variety of emergency scenarios or exercises.

- **Involving Local Agencies on State Systems:** Many states would like to have local jurisdictions participate in the statewide system. This participation would increase the efficiency of the large network and enhance interoperability throughout the state. States should promote their systems to local agencies by offering system demonstrations and showing the advantages of a large, shared system. States have looked at many innovative fee structures for bringing local agencies onto the system. Often, there is no a scientific method, but generally, states look at the usage patterns for participating agencies and determine a fee. States may also seek local entities that are willing to provide infrastructure (i.e., towers) and offer discounts because they are offering something that will enhance the system for everyone.

- **Interoperability Awareness:** One way that states can build awareness of interoperability is through the design of an interoperability wellness checklist. The checklist, which is designed to survey agencies regarding their local agreements for interoperability, interoperability training, available resources for interoperability, agency interoperability plans, and important points of contact provide opportunities for all the agencies within a state to participate in interoperability planning. The checklist may also encourage the development of regional interoperability plans.

**Additional Resources**

Additional information and best practices from the State of Colorado can be found on the World Wide Web at: http://www.co.us/gov_dir/gss/cits/citscomm/DTRINDE.HTM.

Additional information and best practices from the State of Michigan can be found on the World Wide Web at: http://www.mpscs.com

- **Wide Area Systems:** Federal agencies, by virtue of their missions, have a much larger geographic area to cover but a much smaller number of users to accommodate. Federal systems are inherently wide area systems that are used by a more specialized group of public safety officials relative to the users of state and local systems.

- **Frequencies:** Federal and state/local agencies depend on distinct spectrum allocations. As a result, federal agencies can operate in bands in which no state or local agencies operate, and vice versa. Even when operating in common bands, federal and state/local frequency coordination can be somewhat involved. The federal users are subject to NTIA regulations while state/local users are subject to FCC regulations. The NTIA processes, which rely heavily on interagency coordination and agreements, can be quite different from the FCC processes, which are open for public comment and debate.

- **Encryption and Security:** Federal agencies generally have more mandates that require over-the-air protection of transmitted information than do state and local agencies. Additionally, federal agencies sometimes have more stringent security requirements than their state and local counterparts. These additional requirements can affect the cost of a system or increase the difficulty of implementing shared systems with state and local entities.

- **Proprietary Issues:** Federal agencies do not have a strong track record for sharing systems among themselves, thus making the cultural shift to sharing with state and local officials that much more difficult to achieve. Federal agencies must also continue to address control and priority issues that may limit their participation in shared systems.

- **Cost Sharing:** The question of how to equitably divide the costs of a shared system challenges the concept of a federal-state-local system.

- **System Loading:** Any plan for a shared system must take into account the additional system loading that will be experienced during peak usage periods.

- **Interoperability:** Federal agencies do have a need to interoperate with local and state agencies to successfully coordinate routine and emergency activities. These interactions are driving shared systems development. They are also the reason that

Another important consideration is that there can be no "one size fits all" approach to incorporating federal agencies within a shared systems architecture. Factors that may vary by agency include the extent to which federal agency personnel and technical staff:

- Are able to assist with the **design and management** of the shared system;
- Are able to be responsible for **security** management; and
- Are available to support **system development**.

Local officials managing shared systems will need to meet with each federal agency seeking participation on the system to discuss:

- Operations;
- System problem handling;
- System security;
- Funding; and
- Other joint issues.

No forum currently exists to facilitate this dialog. In addition, there is no single point of contact for information on the federal radio communications user population. Each federal agency would need to be asked how many users they would have on the system, and what their expansion plans are. Additionally, federal agencies have identified the following challenges to implementing shared systems with state and local agencies.

- **Regulatory Relief:** Federal agencies need coequal access to operate on shared 700 MHz systems. This would lessen the risks for federal agencies associated with abandoning systems in lower bands.
- **Continued Operations:** As local, state, and federal agencies move to newer technologies, it is critical to maintain backwards compatibility in order to maintain mission operations and achieve interoperability.

redundancy. Increasingly it is important for agencies to work together to define a coherent, cost effective radio communications architecture.

**Ongoing Federal Efforts**

Many federal agencies are in the process of upgrading their communications infrastructure. Because state and local agencies often have the need to interoperate with these federal agencies it is important to keep abreast of recent federal developments regarding radio systems. The following are brief summaries of the current plans of certain federal agencies for their radio communications:

- **Bureau of Land Management (BLM):** The BLM is part of the Department of Interior. The BLM is planning to implement a TIA/EIA-102 (Project 25) based digital radio system, and is currently in the process of purchasing strictly digital radios for its portion of the radio cache located at the National Interagency Fire Center (NIFC) in Boise, Idaho. The remainder of the cache is owned by the Department of Agriculture (DOA), who is undecided on digital or analog narrowband operation.

- **United States Air Force (USAF).** The USAF uses a diversity of communications technologies such as radios, satellite phones, and other tactical communications systems. The USAF will also be looking at the capabilities of commercial services such as multifunction equipment like Nextel and similar services provided by other vendors. Their primary focus is how these different systems will interoperate and what will be the communications environment five-to-ten years from now.

- **Department of Agriculture:** The DOA has three agencies that have significant radio infrastructure. They are the Office of Inspector General, the Animal and Plant Inspection Service (generally located in airports), and the Forest Service. The Forest Service makes up approximately 80 percent of the department's radio activities. Because it covers such large and remote areas of the country, the Forest Service has difficulty finding people with similar coverage requirements. As such, their biggest shared system challenge is finding people with whom they can share radio systems.

- **Department of Justice:** The DOJ is implementing significant changes in its communications systems. It has established a Wireless Management Office (WMO) to centralize oversight, management, and procurement of a common Justice Wireless Network (JWN). The WMO is working to consolidate a number of disparate systems,

- **San Diego:** Consolidating DOJ components onto the Immigration and Naturalization Service (INS) system and enabling interoperability with the San Diego Regional Communications System.

- **Seattle:** Implementing a consolidated dispatch center for all DOJ components in the area.

- **Salt Lake City:** Consolidating DOJ components onto the FBI system and enable interoperability with the Salt Lake City Police Department and the Utah Communications Agency Network (UCAN).

- **Los Angeles:** Demonstrating Nextel as a commercial service alternative for all non-tactical communications in the area.

- **South Florida:** Working through the PSWN Program to develop interoperability solutions among DOJ, the State of Florida, and several counties in the south Florida area.

The JWN is being built on an aggressive schedule, moving from the west coast to the east coast. The WMO has divided the country into four zones (western, central, east, and northeast). The WMO has begun planning and implementation in zones 1 and 2 (western and central). These zones were selected to take advantage of existing resources and narrowband assets, to support communications for the 2002 Olympics, and to support operations along the Southwest Border. JWN completion is scheduled for sometime during 2004.

- **United States Coast Guard:** The USCG has a requirement for maritime VHF frequencies and often uses Channel 16 (FM) as the fallback for their interoperability channels. The USCG is in the process of implementing a national distress system and implementing an asset tracking system.

- **Department of the Treasury:** Treasury is planning to implement a TIA/EIA-102 (Project 25) compliant narrowband radio system. The department's goal is to have consolidated procurement of wireless equipment (LMR initially), develop a multiple vendor contract, operate under the enterprise network concept, explore the use of new technologies such as voice-over-IP, and use commercial services to augment the LMR network. Treasury will also be exploring wireless data options such as CDPD to

12.5 kHz channels) VHF systems by 2005 and UHF systems by 2008. Currently, agencies are doing all they can to comply with these requirements; however, they must balance their fiscal resources and their mission requirements. As such, agencies believe they will have continued difficulty in meeting the deadlines. Agencies have identified the following issues as reasons why the narrowbanding deadlines may be difficult to meet:

- **Encryption** is critical in the federal law enforcement environment. The Digital Encryption Standard (DES) is the minimally accepted standard for encryption on federal LMR systems. Federal agencies will need readily available DES equipment that can work on narrowband radio channels.

- **Over-the-air-rekeying (OTAR)** allows users to update their encryption keys while they are in the field rather than having to take their radios to the shop. Federal agencies will need OTAR on their narrowband radio systems if they are to efficiently use encrypted radio systems.

- Many agencies would like to move to a **trunked** environment, but no vendor offers a trunked system in the federal VHF or UHF bands, which are the only bands where federal agencies currently operate.

## FEDERAL PROGRAMS OVERVIEW

### The Public Safety Wireless Network (PSWN) Program

The mission of the PSWN Program is to plan and foster the implementation of interoperable public safety communications systems. The PSWN Program is using a multi-pronged approach to develop a national implementation plan for interoperability. The program views several challenges as essential building blocks to interoperability: coordination, spectrum, funding, and technology and standards. In support of this approach, the PSWN Program is currently pursuing major activities that include technology assessments, shared systems studies, spectrum analyses, case studies, testbed participation, and program planning and outreach.

To further ensure local, state, and federal participation in achieving interoperability, an independent intergovernmental committee was created to provide guidance and senior-level support to the PSWN Program. The PSWN Executive Committee is composed of senior executives from local, state, and federal public safety agencies who have proven expertise or

- PSWN Program Semi-Annual Report, January 1998 – June 1998
- PSWN Program Semi-Annual Report, July 1998 – December 1998
- PSWN Program Semi-Annual Report, January 1999 – June 1999
- PSWN Program National Performance Review Booklet

**Coordination**

- Fire/EMS Interoperability Study Summary Report
- Fire/EMS Interoperability Study
- Public Safety and Wireless Communications Interoperability Guide
- A Priority Investment for America's Future Safety (Analysis of Combined Fire/EMS Interoperability Study and NIJ Law Enforcement Interoperability Study data)

**Spectrum**

- Federal Spectrum Management Processes Report
- State and Local Spectrum Management Processes Report
- Public Safety and Radio Spectrum Guide
- PSWN Radio Spectrum Policy and Legislative Issues Report
- Commercial Spectrum Auctions Reports (Volumes I, II, and III)
- Federal Coequal Access: Enabling Local, State, and Federal Partnerships (FLEWUG Position Paper)

**Funding**

- Commercial Services Reports (Analog and Digital Cellular, MSS, PCS, CAD, GPS, Nextel, SMR, ESMR, Wireless Data, CDPD)
- DLMR Security Problem Statement
- DLMR System Security Guidelines Recommendations
- Security Field Data Collection and Analysis Reports (Site #1, Site #2, Site #3)
- LMR System Recommended Security Policy
- LMR System Security Planning Template
- Public Safety Communications Security Briefing
- Public Safety Communications Security Guide
- LMR Replacement Cost Study Report
- Commercial Services Assessments
- Cost Study Data Characterization Report
- 800 MHz Study Report
- Conventional and Trunked Radio Systems Comparison Report

These reports can be obtained by either visiting the PSWN Program's web page at www.pswn.gov or calling 1-800-565-PSWN. Through the release of its reports, the availability of the web page, and the sponsorship of events such as symposiums, the PSWN Program is providing an "information clearinghouse" to assist local, state, and federal public safety agencies implement interoperable radio systems.

**The Interagency Working Group on Funding of Public Safety Wireless Communications Systems (IWGF)**

**National Institute of Justice (NIJ) Law Enforcement Interoperability Study**

In 1997, the NIJ administered a survey on law enforcement interoperability. The NIJ's National Law Enforcement and Corrections Technology Center, located in Denver, Colorado developed the survey. The purpose of the survey was to compile quantitative data from state and local law enforcement agencies nationwide on their current and future use of communications equipment and services and on their experiences with interoperability. The 11-page, 268-question survey was sent to over 2,700 state and local law enforcement agencies, sheriffs' offices, and "special police." A total of 1,334 agencies answered the survey for an overall response rate of 48 percent.

Key findings of the survey are documented in the report ***State and Local Law Enforcement Wireless Communications and Interoperability***. This report is available through the NIJ web site at www.nlectc.org. Key findings regarding law enforcement interoperability include:

- The need for interoperability is common among law enforcement agencies. Funding and radio frequency incompatibility are identified as the most significant barriers to interoperability.

- Thirty-five percent of law enforcement agencies believe state and federal mandates are needed to ensure interoperability, but the majority believes local planning best meets their needs. Many agencies indicated that funding would make mandates more acceptable.

- Discrepancies in state and local perceptions on formal state interoperability plans suggest the need for more dialogue between state and local law enforcement agencies on the issue of interoperability.

**NIJ Advanced Generation Interoperability for Law Enforcement (AGILE) Program**

NIJ has established the AGILE program to deal with all of NIJ's law enforcement interoperability activities. The program is planning to participate in testbeds and demonstrations of interoperable technologies in an operational environment. One such test may involve the ACU 1000 switching device. The AGILE program is also performing research and development on other interoperability technologies and working to fund projects for more efficient use of

**NIJ Video – "Why Can't We Talk?"**

In September, 1998, the NIJ completed a high-quality informational video emphasizing the importance of communications interoperability and other radio systems issues to the public safety community. The 13-minute video includes testimonials from emergency services personnel, police officials, firefighters, and policymakers who have encountered interoperability-related problems and proposed solutions. The target audience for the video is high- or mid-level state and local public officials. The video can be used in conjunction with efforts to educate decision makers about public safety radio communications and the critical need for interoperability.

**PSWN Program Fire/Emergency Medical Service (EMS) Interoperability Study**

The PSWN Program's Fire/EMS Interoperability Study is a complement to the NIJ law enforcement study. This study surveyed fire and EMS organizations throughout the country to further the understanding of public safety interoperability challenges. Responses to a mail-in questionnaire provided insight into the current radio communications infrastructure supporting the fire and EMS communities, defined interoperability requirements for these communities, identified shortfalls, and determined the level of knowledge among fire and EMS officials regarding key communications technologies.

The PSWN Program distributed 3,398 questionnaires throughout the fire and EMS communities. A total of 1,045 agencies answered the survey, for an overall response rate of 31 percent. The PSWN Program released the report, ***PSWN Program Analysis of Fire/EMS Interoperability,*** in April 1999. Preliminary findings from the study include:

- Local fire and EMS agencies require extensive interoperable communications to accomplish their missions. They interoperate on a daily basis with other local public safety agencies and have an occasional need to interoperate with state or federal organizations for mutual aid or task force operations. State forestry agencies are the only state-level fire or EMS organization that requires extensive interoperable communications. They are in regular contact with public safety agencies from all levels of government.

- A lack of interoperability affects the ability of fire and EMS agencies to accomplish their missions. The larger agencies in particular experience difficulties interacting with

- Fire and EMS agencies currently operate LMR systems that are old and use basic technology, but are moving toward more advanced technologies to meet their communications needs. More than half of the agencies will be upgrading or replacing their systems within the next 10 years. The majority of agencies currently operate analog, conventional systems in high-band VHF, and systems are generally near the end of the eight-to-ten year life cycle. Agencies using advanced technologies have more confidence in their ability to handle interoperability situations.

- Funding problems and operations in different frequency bands are the biggest obstacles to interoperability for fire and EMS agencies. Funding is a problem for more than two-thirds of the agencies, regardless of agency size or type. Large agencies find different frequency bands to be more problematic. Agencies with funding problems are less confident in their ability to handle interoperability situations.

- Inadequate planning and political and institutional factors are moderate obstacles for fire and EMS agencies. Mandates for interoperability have divided support within the community. Agencies have an overall sense of improved confidence to handle interoperability in the future, indicating a willingness to overcome these obstacles.

- Fire and EMS agencies are unfamiliar with current initiatives related to wireless communications and interoperability. This is even true for those planning to replace or substantially upgrade their LMR systems. Despite a lack of knowledge of specific standards development, agencies recognize the benefits of standards-based communications systems and a majority of those surveyed indicated that their agency was at least moderately likely to adopt Project 25 interoperability standards for their next LMR system.

The PSWN Program is combining the findings from the law enforcement and fire/EMS surveys to develop a baseline of information regarding public safety communications interoperability. The combined report will be designed to serve as an advocacy piece to compel senior decision-makers to improve public safety communications systems and to raise awareness of key interoperability issues and obstacles. The report will show how increased threats, changing mission requirements, and aging systems are driving the replacement or upgrade of public safety communications systems.

The combined report will also show that both law enforcement and fire/EMS agencies experience common problems (e.g., dead spots in coverage, channel congestion) and obstacles to

agencies operating along the Southwest Border. Representatives from over 400 public safety agencies were interviewed during the Summer of 1998. Data was collected on infrastructure and radio equipment, interoperability requirements, radio traffic characteristics, security needs, operational problems, and the use of commercial services. Analyses are being conducted from collected data to help identify ways to optimize radio resources, improve mission performance and interoperability, and conserve spectrum. Recommendations for integrating or linking systems to foster interoperability will ultimately be developed, and testbeds will be created for pilot implementation. Preliminary findings from the Southwest Border data collection include:

- The diverse missions of federal agencies create different radio needs. Federal agencies use a variety of radio equipment, and sometimes are faced with "bad guys" that have more sophisticated equipment. Agencies often have new hand-held or mobile radios, but rely on old LMR infrastructures.

- Unreliable radio system performance, poor coverage, radio interference, channel congestion, and unauthorized monitoring hinder the ability of federal agencies to carry out their missions. Many agencies are augmenting their radio networks with commercial wireless services (e.g., cellular phones and paging) to mitigate these problems.

- The local agencies commonly use old technology in their LMR systems. Inadequate funding often precludes needed maintenance or system modernization, resulting in performance problems. Individual agencies migrate to newer technologies as funding becomes available, resulting in disparate systems that reduce interoperability.

- Federal agencies operate predominantly in high-band VHF (162-174 MHz), while state and local agencies are divided among high-band VHF, UHF (420-470 MHz), 800 MHz, and low-band VHF (30-70 MHz).

- Public safety missions along the Southwest Border that require coordination among local, state, and federal agencies are common and would benefit greatly from enhanced radio interoperability.

**Advanced Law Enforcement & Response Technology (ALERT) Vehicle**

Under sponsorship of the US Department of Transportation, and with support from the PSWN Program, NIJ, and the International Association of Chiefs of Police, the Texas

to directly enter traffic citations into a database, collect visual and written accident data, consolidate reports and images, upload reports to the base station, review, edit, and print reports at the station, and email reports. The entry of reports directly into the computer via the ALERT vehicle helps reduce paperwork and streamline data collection. Public safety applications beyond typical traffic citations and accident reports are planned. Also planned is a testbed focused on supporting the development of technologies designed to achieve wireless interoperability solutions that integrate into the ALERT platform.

The ALERT program has been divided up into three distinct phases. During the first phase, TTI developed two prototype vehicles. The program is currently in the second phase. During this phase, the ALERT program is working with the PSWN Program to develop testbeds in multiple operating environments. Six cars have been developed for the testbed (two each for the U.S. Park Police, USSS, and Alexandria, VA Police Department) that will take place in the Washington, DC metropolitan area. The third and final phase, will involve the commercialization of the ALERT vehicle. The ALERT program is looking at potential partners, reasonable pricing, and open architectures for this phase of the project.

**National Crime Information Center (NCIC) 2000**

The NCIC was created by the FBI in 1967 to help criminal justice agencies improve their operations by providing a nationwide information system to support investigations. The system is currently undergoing a major upgrade known as NCIC 2000. The success of NCIC and its increased usage, coupled with technological advances such as mobile data terminals, laptops, and increased capabilities of local, state, and other federal systems, led to the NCIC 2000 initiative.

In addition to current capabilities, NCIC 2000 will provide many additional features. These enhanced features include fingerprint images, enhanced name searches, probation and parole lists, on-line manuals, improved data quality, information linking, mugshots, other images (e.g., vehicles, boats, or vehicle and boat parts), convicted sex offender lists, access to SENTRY (an index of individuals incarcerated in the federal prison system), delayed inquiry, and an on-line ad-hoc inquiry. NCIC 2000 went on-line in July 1999 and transmitted its first mug shot over CDPD on August 18, 1999. NCIC 2000 is currently meeting the following service standards:

- Availability 24 hours a day, seven days a week;
- The ability to process inquiries in two seconds or less;

- Level One is the lowest level of service and allows for users to call the dispatcher with a request and have the answer returned over radio.

- Level Two allows the officer to run an inquiry from his/her vehicle.

- Level Three allows imaging to be sent to the dispatcher via a wireline transmission, but the information still cannot be relayed to the officer in the field.

- Level Four is the most sophisticated level of service and allows data and images to be sent directly to the officer in his/her vehicle.

The PSWN Program will be working in conjunction with the NCIC 2000 program to evaluate the feasibility of integrating NCIC 2000 into various mobile data communications systems. This wireless applications test program will assess the reliability and ease of use of the NCIC 2000 hardware and software in different wireless environments. The wireless applications test program will also assist in developing guidelines regarding interface to various wireless communications and increase liaison between local, state, and federal criminal justice agencies regarding mobile data communications. To date, the test program involves 19 vendors, 5 public safety agencies, and 4 different infrastructures (e.g., CDPD, private voice/data system). The wireless applications test program's next steps include testing these technologies in an operational environment. Several local, county, state, and federal agencies have expressed interest in participating in the field tests.